
pSMILE
SAFETY·QUALITY·RESULTS
Urine Sediment Identification
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Objectives

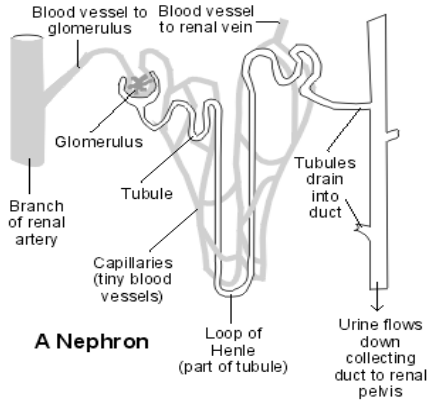
- At the completion of this presentation you will be able to:
  - Recognize the chemical tests included in a urine dipstick
  - Perform a Microscopic Analysis of a urine sample
  - Identify both normal and abnormal microscopy in an urine sample
  - Explain what is needed for Quality Assurance for Urine Sediment analysis.

Course Outline

- Review the kidney structure
- Review rapid chemical tests- multistix
- Discuss Microscopic Analysis
- Identify normal and abnormal urine sediment
- Explain Quality Assurance for Urinalysis
- Review Case studies

Kidney Structure

Kidney Structure - Overview



- Approximately 1 million nephrons in each kidney
- Waste products and water pass along the tubule
  - Water, salts, sugar, & other large molecules reabsorbed within limits.
  - Excess products & Urine are excreted.

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–First we will go do an overview of the kidneys.

- The kidneys are the organs involved with the production of urine. They are responsible for regulating the body fluids, acid-base and electrolyte balance and waste excretions. This occurs through a complex process of filtration, reabsorption and secretions.
- This process occurs in the nephron which is the functional unit of the kidney located in the cortex of the kidney. There are approximately1 millions of these units. You can see one on the screen. A nephron consists of a capillary network and a long tubule divided into 3 parts: the **proximal, loop of Henle and the distal tubule.** Part of the capillary network is formed into a ball-like structure called the **Glomerulus** that sits in a capsule-like structure called the **Bowman's capsule**. Blood enters the nephron under pressure and the structure of the glomerulus helps to force the filtrate, consisting mainly of water and solutes, into the tubule so that the complex process of filtration, reabsorption and secretion can begin.
- Each nephron empties into the collecting tubules which then empties into the bladder and eventual is expelled through the urethra
- Urine sediment may contain a wide variety of substances, such as cells, (RBC, WBC, and Epithelial), cast, crystals, bacteria, fungus and artifacts such as fibers, talc.
- The most important consideration in microscopic examination is to distinguish the content of normal from abnormal sediment.

Urine Dipstick

Rapid Chemical Test

- Bilirubin
- Blood/Hemoglobin
- Glucose
- Ketones
- pH
- Protein
- Urobilinogen
- Nitrite
- Leukocyte Esterase
- Specific Gravity

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Here are the most common test perform on the urine dipstick. The dipstick is usually performed before the microscopic analysis. Should be performed on a well mixed sample. These test can be qualitative with positive negative results or for semi quantitative graded such as 1+ through 4+ or terms such as trace, moderate or large amount. Depending on the test the dipstick is the screening test and positive test are verified by confirmatory test such as for protein and glucose

Microscopic Analysis

Microscopic Analysis

- Provides valuable information for diagnosis of renal and other abnormalities.
- First check macroscopically for cloudiness, color, possible blood and any syrupy consistency.
- Helps provide clues regarding the nature of the sediment

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A properly performed microscopic exam of urinary sediment- Read slide

Syrupy can indicate mucus and casts.

It is crucial that the structures occurring in the urinary sediment be identified correctly and that the diagnostically significant element be distinguished from extraneous substances.

Basic Technique

- Thoroughly mix sample to ensure dispersal of constituents
- Pour 12 ml (10-15mL range) into conical centrifuge.
- Centrifuged at 1500 rpm (400-450g) for 5 minutes.
- Do not having braking on will re-suspend pellet

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Just want to state that what is presented in this lecture today are suggestions. As always you should follow your laboratory SOP. Let go through the basic technique for urine sediment testing.

Basic Technique

- Decant the supernatant leaving 1 mL. (Can be saved for further chemical testing)
- Gently re-suspend sediment.
- Place one drop of mixed sediment on clean, dry glass slide.
- Apply cover slip.
- Try to avoid bubbles.

To re-suspend an us a finger-flicking technique to re-suspend.

Scanning of Microscope Slide

- First start with 10x objective.
- Examine at least 10-12 fields to check for even distribution of elements
- Examine perimeter of coverslip for:
  - Epithelial cells (squamous)
  - Casts (Hyaline and granular)
  - Mucus
  - Crystals
- Scan a minimum of 10 fields.

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If not evenly distributed should prepare a new one.
Should examine the perimeter for squamous epithelial cells, cast and mucus. Due to their size have a tendency to be pushed to the perimeter.
Should scan at least 10 fields. Each of these elements should be enumerated in each field than averaged by dividing the number of views

So if total hyaline cast seen in 10 fields is 20 then the average would be 2/lpf

Scanning continue---

- Change to 40x objective for more detailed quantitation.
- RBC, WBC, Cellular Cast, Bacteria/fungi and renal and transitional epithelial cells are reported as average number per high field.
- Minimum of 10 fields viewed.
- Cells/field counted then average calculated.

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Once done scanning low field should drop down to higher power usually 40x.

Microscopic Exam

- Low Power Field
  - Squamous Epithelial cells
  - Hyaline casts
  - Granular casts
  - Crystals
- High Power Field
  - RBC
  - WBC
  - Renal tubular epithelial cells
  - Transitional epithelial cells
  - Cellular casts for identification
  - Bacteria/fungi/yeast

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The following elements should be exam on low power
The following elements should be exam on high power

Reporting Options

- Range or "+"
  - 1-20/HPF (1+)
  - 21-40/HPF (2+)
  - 40-60/HPF (3+)
  - 60-80/HPF (4+)
  - TNTC (Too numerous to count)
- Descriptions
  - Trace
  - Few
  - Occasional
  - Moderate
  - Many
  - TNTC (Too numerous to count)

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Depends on your laboratory policy but there are different ways to result your findings

Usually for WBC, RBC, Epithelial Cells and cast use a range/+ system

For squamous epithelial, hyaline cast the are reported with a range using lpf

For crystals usually use descriptive reporting.
Also for bacteria/fungi reported if seen.

Normal Sediment Reference Values

- RBC – 0-20 RBCs/hpf
- WBC – 0-8 WBCs/hpf
- Squamous Epithelial – 0-few/hpf
- Renal epithelial cells – 0-few/hpf
- Transitional epithelial cells – 0-few/hpf
- Crystals – Occasional/lpf (Common crystals)
- Bacteria – none/hpf –if clean catch.
- Yeast – none/hpf
- Hyaline Cast – 0-2 /lpf (use hpf to differentiate)

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Here are normal sediment reference values. Again they could be different depending on your laboratory policy

Common Sources of Errors

- Delayed Analysis
- Improper Illumination- may miss casts
- Improper placement of sediment on slide
- Dried Slide
- Confusion due to artifacts

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- Should be examined while still fresh. Sediment changes with passage of time, should be performed within 2 hours after collection. If not should be refrigerated or preserved
- Most common error. Subdued light is necessary so that hyaline semi-transparent structures are not obscured by intense illumination
- Should only do one patient per slide. If more than one patient on slide can lead to mixing of samples
- If slide dries out a valid exam is impossible. It can cause distortion of structures.
- Extraneous elements are also common problem. Must become familiar with the relevant elements so that extraneous structures are not confused. We will show some of the most common artifacts in this presentation.

Physical appearance of urine and results from chemical test provide clues to help identify urine sediment.

Microscopic and macroscopic results should correlate.

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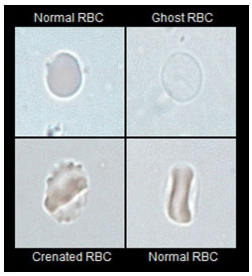
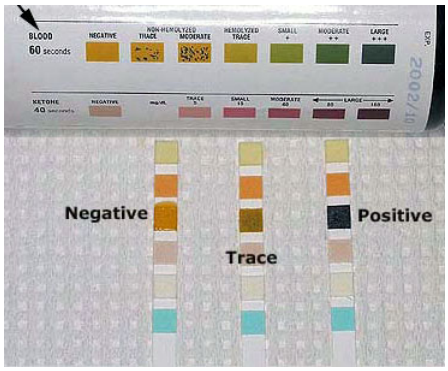
By using both the physical and macroscopic (chemical) results should be able to correlate what you see in the microscopic analysis

Hemoglobin/Blood

- Positive Hemoglobin/blood indicates either intact or lysed RBC.





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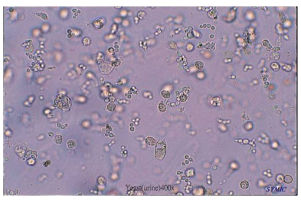
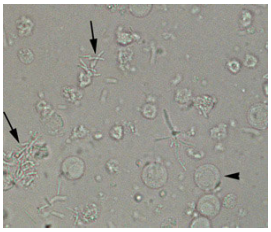
Nitrites

- Positive nitrite indicates bacteria/yeast, WBC.

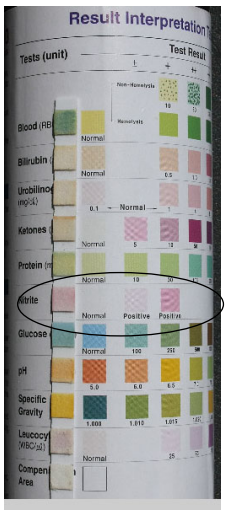


Budding Yeast

Pseudohyphae

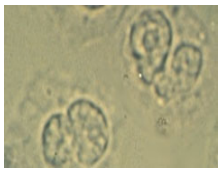


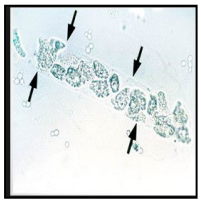
Bacteria



Protein

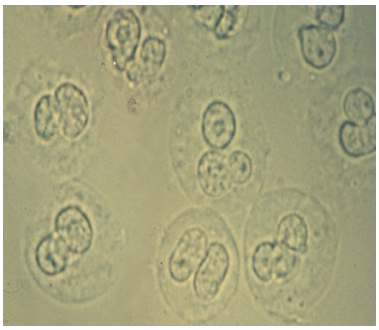
- Positive protein can indicate casts, epithelial cell, WBC, bacteria.





Leukocyte Esterase

- Positive leukocyte esterase indicates WBCs present.



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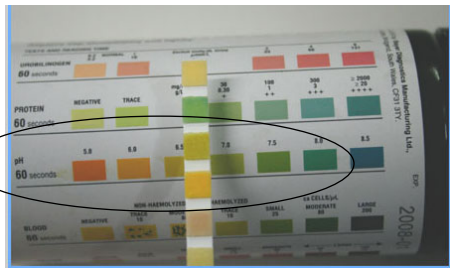
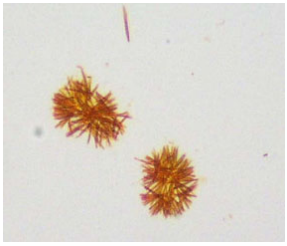
pH

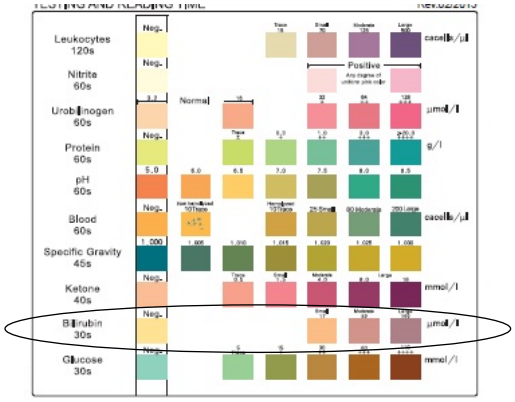
- The pH can help to identify the type of crystals, if any.



Bilirubin

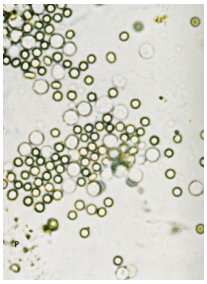
- Positive bilirubin can indicate specific crystals.





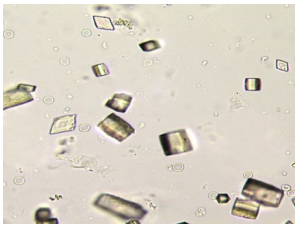
Normal & Abnormal Microscopy Review

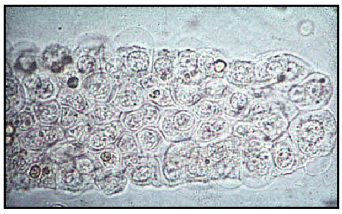
- Cells
- Casts
- Crystals



RBC's & WBC's

Uric Acid Crystals





Epithelial Cast

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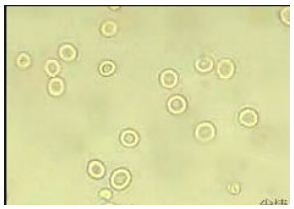
Now we will go into what can be seen on microscopic analysis

Cells

Erythrocytes/RBC

- Round or oval biconcave disc
- No nucleus
- Abnormal in increase numbers
- Faint yellow-orange or red
- Can be confused with yeast



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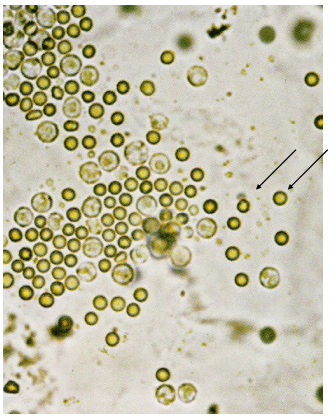
First we will look at RBC's. RBC's usually originate from the glomerulus or they can be contaminations especially in menstruating females. They are usually pale, yellow, smooth biconcave disk. They appear in low numbers in normal urine. They can be crenated in hypertonic urine and swell to "ghost" forms in hypotonic urine. Can be confused with yeast at times.



- **Red Blood Cell**
- What multistix result do you expect to be positive?
- Blood/Hemoglobin

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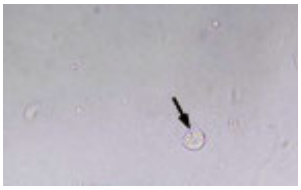
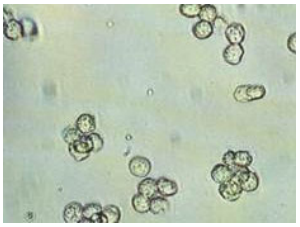
Here is another slide containing RBC.
Hemoglobin
Sometimes you will have positive hemoglobin and no visual RBC, this can occur when the RBCs have lysed.
Sometimes they can be confused with yeast, just remember that yeast vary in size and appears egg-shaped
The shape and size of RBCs may also vary with the concentration of the urine, when the specimen was collected and how it was stored.

Leukocytes/WBC

- Colorless cells
- Most frequent is PMN(segs)
- Normal 3-5 seen
- Increased in inflammatory conditions





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WBC are usually found in low numbers in normal urine. They are spherical, dull gray or yellow. Usually they are polymorphonuclear neutrophils. They are found increased with inflammations and acute infections.

- **White Blood Cell**
- What multistix result do you expect to be positive?
- Leukocyte Esterase

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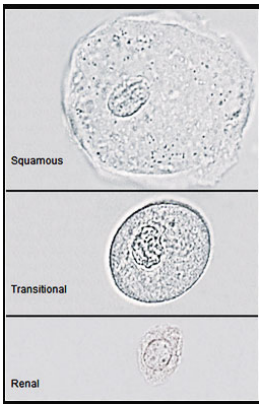
Here we see a high magnification showing WBC, you can actually see the lobes on these cells. WBCs usually originate in the glomerulus and also can be sloughed off in the the urethra.
The leukocyte esterase should be positive on the dipstick

Epithelial cell Comparison

- Squamous is biggest
- Transitional is similar to but smaller than squamous and larger than renal
- Renal smallest sometimes confused with WBC's



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There are three types of Epithelial Cells that can be seen in urine – renal, transitional and squamous
Here we have a comparison of the three different types of epithelial cells.

Squamous Cell

- Large, flat, thin cells
- May be round, polygonal, rectangular or rolled into a tube
- Nucleus is size of a RBC usually centrally located.
- Can contain granules in cytoplasm.
- Line urethra, bladder and vagina
- Form protective barrier
- Normal finding.
- Increase number indicate not a clean voided specimen

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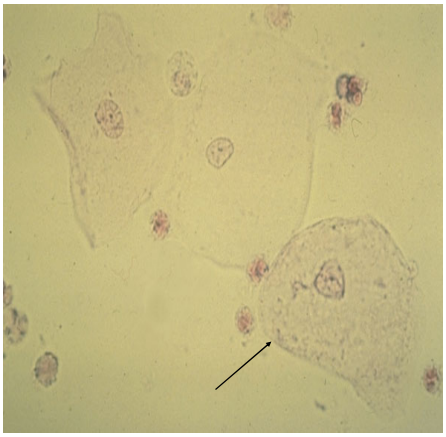
They are normally sloughed off as old cells into the urine. An increase in squamous epithelial cells can indicate an inflammation.
They are usually large, flat irregular shaped cells with small nucleus and abundant cytoplasm. They remind me of fried eggs.



- **Squamous Epithelial**
- What multistix result do you expect to be positive?
- Protein
- Possibly Nitrite

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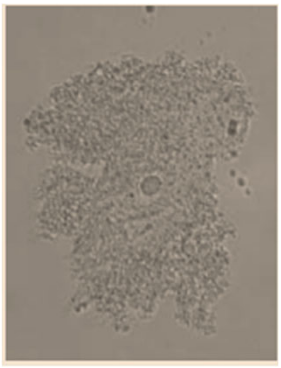
Here is another slide. Do you notice anything about this slide? Stain has been added to make the cells more visible.
If numerous the protein may be positive on the urine dipstick. Also nitrite due to not being a clean catch

Clue Cells

- Squamous epithelial cell with large amount of bacteria adhering to them.
- Gives a “shaggy” appearance
- Originates in vaginal mucosa
- Presence indicates Bacterial Vaginosis (BV)



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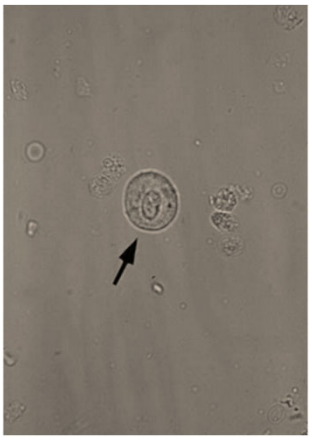
Sometimes you may see these in the urine.
They are squamous cells coated with bacteria
Considered a contaminant from the vaginal mucosa.
Indicates a bacterial vaginal infection

Renal Epithelial cell

- Difficult to tell from transitional
- 20 to 30 u similar polyhedral shape and nuclear size
- Most clinically important
- Diseases of kidney and renal tubule can cause excess
- Usually small number



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It can be hard to differentiate between Renal and Transitional epithelial cells. Usually on EQA surveys they will accept both answer if they have either on a slide.
At labs that I have worked in we usually combined the Transitional and Renal Tubular epithelial cells into one category.
Renal appear larger than a WBC with a single nucleus. Also the cytoplasm will not be as granular as WBC. Usually indicate some type of damage occurring in the kidney

- **Renal Epithelial**
- What multistix result do you expect to be positive?
- Serum chemistry panel- look at kidney analytes
- Possibly Protein

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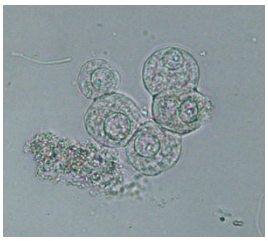
Renal appear larger than a WBC with a single nucleus. What chemistry result do you expect to be positive

Transitional Epithelial cell

- Spherical, ovoid, polyhedral
- Smaller than squamous, larger than renal
- Increase with infection, post renal catheterization, urinary stones



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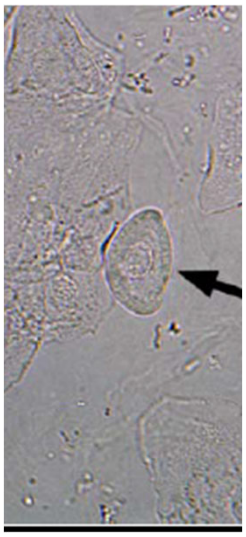
Because these cell line the lumen and are in direct contact with the urine they are easily sloughed off and present in the sediment. They are commonly observed as being spherical or “Balloon-shaped” due to swelling. These can be confused either with WBC or renal epithelial cells.. Can be seen as result of catheterization.

- **Transitional Epithelial**

- Present in small numbers
- Large number denote abnormal state.
- Can occur in groups or singly



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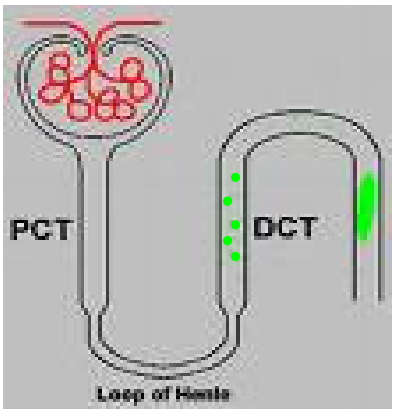
Their presence in small numbers is not pathologic and is to be expected. Large number are uncommon and usually denote an abnormal state. They can occur in groups but more often they occur singly or in pairs and may be difficult to distinguish from renal epithelial cells.

Casts

Kidney Structure – Cast Formation



- Protein – Tamm-Horsfall
  - Secreted by tubule cells
  - Distal convoluted tubule (DCT).
- T-H Protein, albumin & immunoglobulin
  - Combine to form cast
  - Include tubule contents
- Illustration:
  - Protein secretion (green dots)
  - Hyaline cast (formed in the collecting duct.

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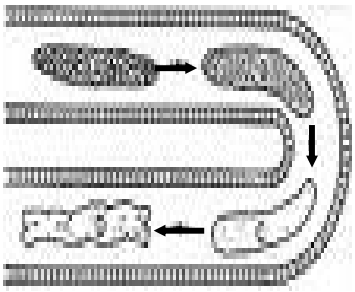
Now we will go onto Cast

- Urinary cast are formed in the lumen of the tubules of the kidneys. They are composed primarily of proteins and a specific mucoprotein call Tamm-Horsfall secreted by cells in the kidney tubule.
- Factors that contribute to their formation are decrease urine flow, increase acidity, high solute concentration
- s and the present of protein. On the slides that follow the protein content is only an estimate, can vary with the amount of cast, etc. for the urine.
- Formation starts in the distal and collecting tubules where there is the highest concentration of solutes and acidity. Usually when cast are present you will see an increase in protein concentration of the urine.
- Increase number of casts is an indicator of renal problem.
- They are classified on the basis of their appearance and content.

Cast Formation



- Tubule contents wrapped into protein matrix
  - None = Hyaline
- Progression
  - Cellular
  - Coarse Granular
  - Fine Granular
  - Waxy – (Theory)

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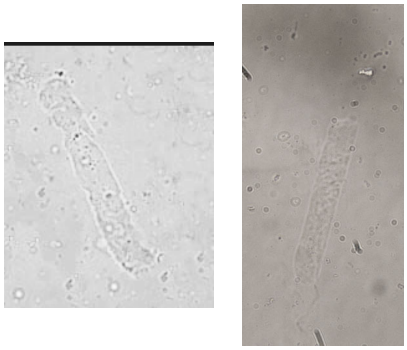
Cast change and their appearance alters as they pass through the nephron and the lower urinary tract. When they are form

- Hyaline casts are formed when there are no other solutes in the tubules composed of only protein. They are the most frequently occurring cast in the urine.
- 2nd click As for other type of cast it is thought that when RBC, WBC or epithelial cells are present they can get incorporated in to the cast forming cellular cast.
- 3rd click-As the cellular contents break down they become coarse granular first
- 4th click then fine and
- 5th click
- waxy .One theory that the waxy is the final stage of breakdown. The other thought is that waxy are formed directly from severe chronic disease without breakdown from other cast.

It is important to remember that the waxy cast is an indication of serious kidney disease.

Hyaline Cast

- Colorless
- Transparent
- Low refractive index
- Can easily be missed with ordinary bright field light scope
- Cylindrically shaped elements
- Seen in healthy and also with renal disease
- Small numbers usually



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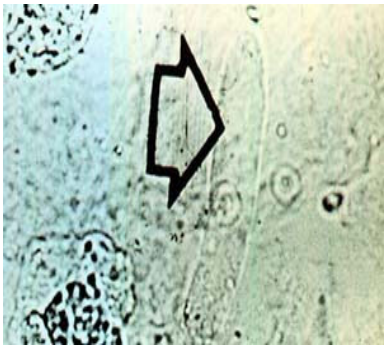
(Ask if they use cover slips on the urines, also comment that if they do use coverslips that cast have a tendency to migrate to the edges. Also using low magnification and low light can help see the hyaline cast better.)

Let's go over hyaline cast: They can be seen in normal urine, and sometimes after strenuous exercise. Ends are rounded, with parallel sides.



- **Hyaline Cast**
- What rapid chemistry result do you expect to be positive?
- Protein:
  - Negative – 1+

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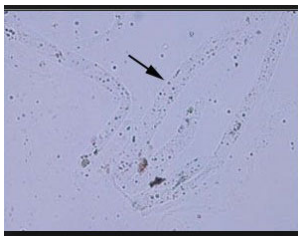
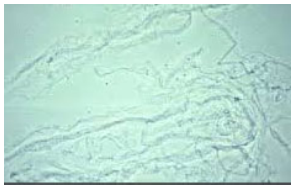
Here is another view of a hyaline cast, what chemistry would you think positive 2nd click – protein, but not usually high concentration.

Mucus

- Can often be seen in urine
- No pathologic significance
- Can be mistaken for hyaline cast
- Does not have the smooth parallel sides, cylindrical shape

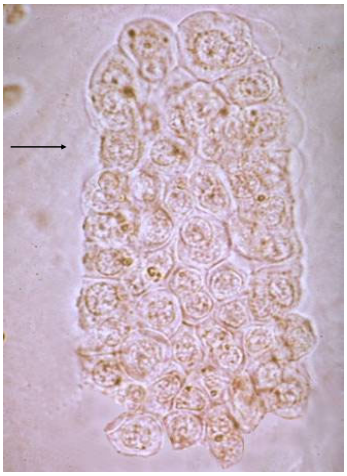




44

Can be confused with Hyaline casts

Cellular Cast



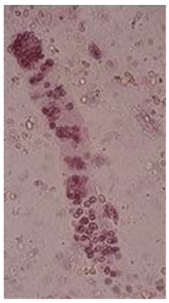
- Key Features
  - Cellular: Few – Numerous
  - Cylindrical
  - Rounded Ends
  - Color – depends on the contents
  - Nearly Parallel sides
  - No Dark Edges

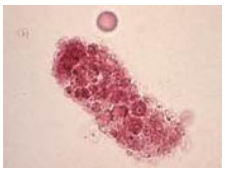
45

Cellular Cast: depends on their content what they are named such as RBC, WBC, and Epithelial and rarely Bacterial cast which contains unicellular microorganisms.
Not normally found in urinary sediment. When observed indicate a pathologic state

RBC Cast

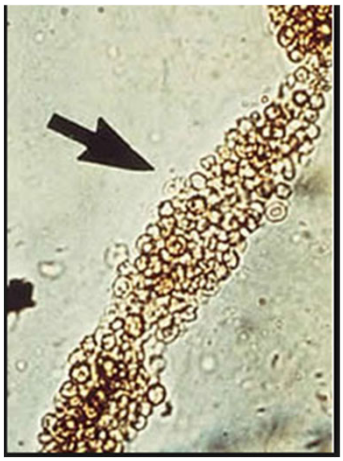
- Least common cast
- Most significant
- Tinged red or brown
- Seen in freshly voided specimens
- Differentiated by presence of intact RBC





46

Seen in acute glomerulonephritis, all glomerulopathies and malignant hypertension.

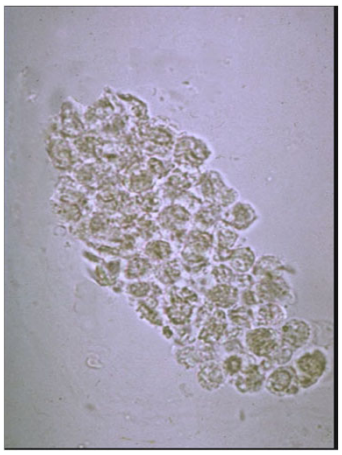


- **RBC Cast**
- What rapid chemistry result do you expect to be positive?
- Protein:
  - 1+ to 3+
- Hemoglobin/Bld

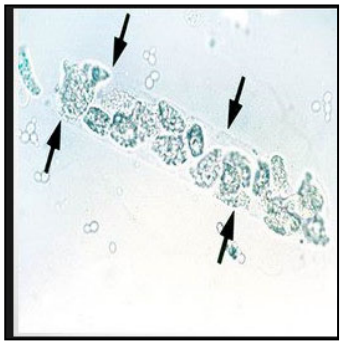
47

WBC Cast

- Easily Identified
- Associated with kidney infections
- Usually PMN's
- Can be confused with Epithelial Cast
- WBC cast has granular cytoplasm



48

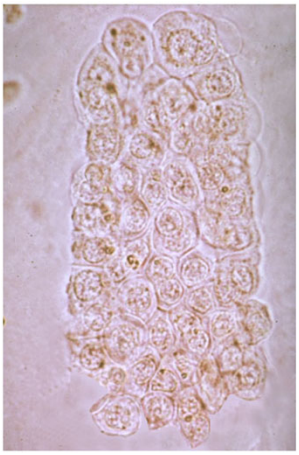


- **WBC Cast**
- What rapid chemistry result do you expect to be positive?
- Leukocyte Esterase
- Protein
  - 1+ to 3+

49

Epithelial Cast

- Can be hard to distinguish from WBC cast.
- Not present in healthy person
- High refractive index
- Cytoplasm is agranular
- Cells have polyhedral elongated or columnar shape



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50

This happens to be a Renal epithelial cast.

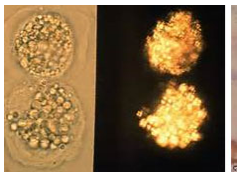
- **Epithelial Cast**
- What rapid chemistry result do you expect to be positive?
- Protein
  - ≥1+

51

The can be found in all conditions associated with tubular damage such as acute tubular necrosis, acute interstitial nephritis

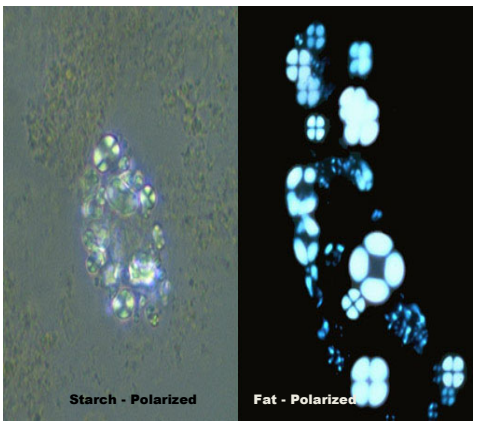
Fatty Cast

- Yellowish tinge
- Contains large spherical, highly refractile fat droplets
- Polarized light show "Maltese-cross" pattern
- Associated with marked proteinuria and nephrotic syndrome



52

Starch can be confused, false Maltese cross



- **Fatty Cast** –
- What rapid chemistry result do you expect to be positive?

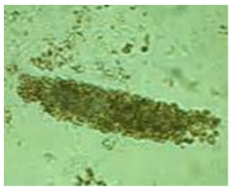
- Protein
- Other rapid chemistries- Depends on the contents

53

Here we have polarized views comparing starch and fat

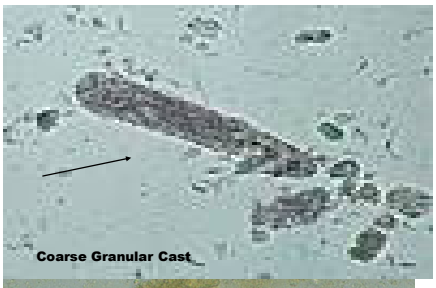
Granular Cast

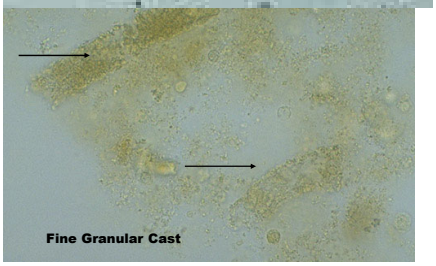
- Fine or coarse granules
- Can be normal, especially after vigorous exercise
- Seen in renal disease patients



54

Due to granules easier to see. Granules may be present throughout the entire cast matrix or confined to one area or loosely scattered. When the granules are small and difficult to distinguish is call fine granular cast. When granules are large it is called coarse granule cast. These type of cast may be produces by the breakdown of cellular cast or created from aggregation of protein- basically the breakdown of cells.





- **Granular Cast**
  - Coarse - black
  - Fine – grey/pale yellow
- Key Features
  - Cellularity Indeterminate
  - Cylindrical
  - Rounded Ends
  - Nearly Parallel sides
  - No Dark Edges

55

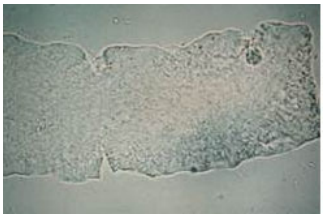
- **Granular Cast (Hemoglobin)**
- What rapid chemistry result do you expect to be positive?
- Protein
- Other - Depends on the origin:
  - Blood/Hemoglobin

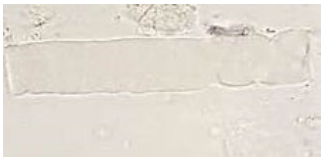
56

Here we have another example of a granular cast which happens to be from the breakdown of RBC. If you can look hard can see a partially intact RBC

Waxy Cast

- High refractive index
- Blunt or broken off ends
- Parallel margins may show notching
- Colorless, pale yellow, waxy appearance
- Abnormal finding





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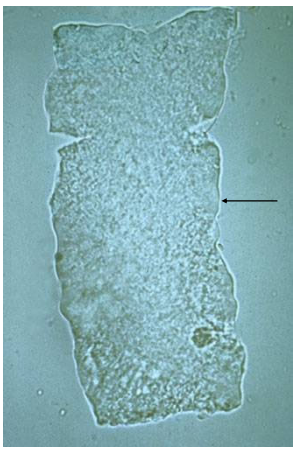
– they have high refractive index, they indicate severe chronic renal involvement.



- **Waxy Cast**
- Key Features
  - Opaque (Refractive)
  - Homogeneous (non-cellular)
  - At Least One Flat/Blunt End
  - Short
  - Possibly Cracked, Serrated or Convoluted

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- **Waxy Cast**
- What rapid chemistry result do you expect to be positive?
- Protein
  - >3+

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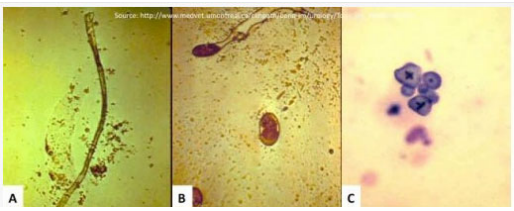
Here is another slide showing you a waxy cast.

Artifacts

Microscopy – Artifact

- A – Hair
- B – Pollen grain
- C- Talcum powder

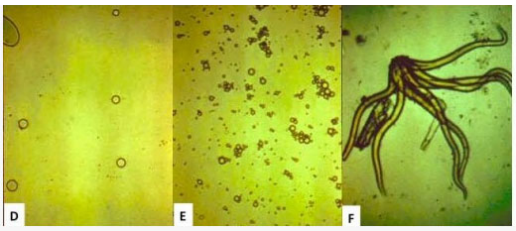


61

Various materials and substances can occur in the urinary sediment that are not endogenous to the urinary tract per se. Can come from male reproductive organs, the vagina or vulva, the skin, feces or the environment.
Here are 6 examples of artifacts in urine

Microscopy – Artifact

- D – Air bubble
- E – Fat droplets
- F - Cloth fiber

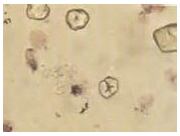


62

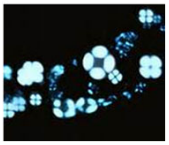
Various materials and substances can occur in the urinary sediment that are not endogenous to the urinary tract per se. Can come from male reproductive organs, the vagina or vulva, the skin, feces or the environment.
Here are 6 examples of artifacts in urine

Starch granule

- Colorless
- Irregularly round with dark striation to the center
- Asymmetric “Maltese cross” in polarized light. Can be confused with fat bodies.
- Frequent contaminant



Starch polarized



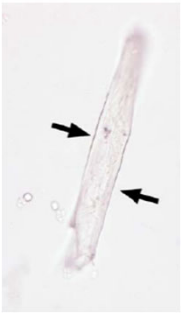
Fat droplet polarized

63

Note how the fake droplet “Maltese cross” is more symmetrical than the starch on the left

Fiber

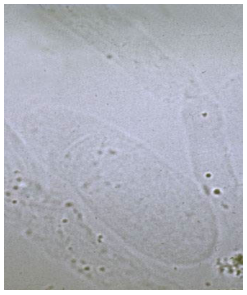
- Defined shapes
- Flat
- Refractile
- Frayed ends
- Non-cylindrical shapes
- Dark edges



64

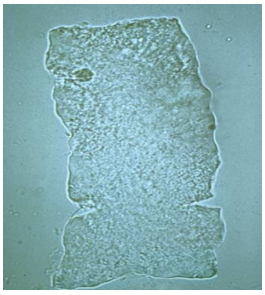
One particular artifact that can be confused with a hyaline cast is fiber. Things to look for to differentiate it from a cast is: Fiber has

Cast/Artifact Comparison



Hyaline Cast

- Opaque
- Cylindrical
- Blunt Ends



Waxy Cast

- Transparent
- Cylindrical
- Rounded Ends

Fiber

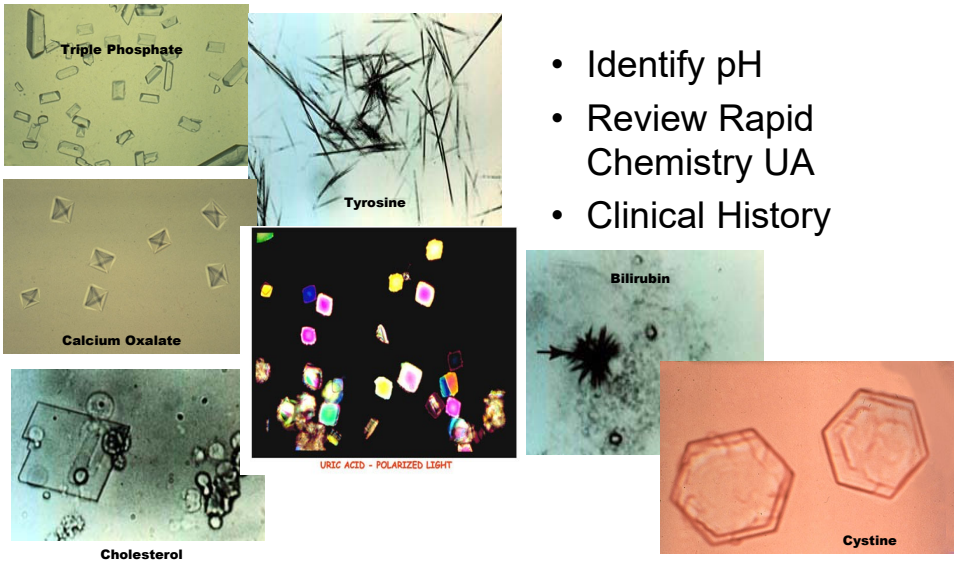
- Refractile
- Flat
- Dark Edges

65

Here is an comparison of two different casts and fiber

Crystals

Microscopy – Crystal ID



- Identify pH
- Review Rapid Chemistry UA
- Clinical History

Now we will review crystals
Things that will help with the Id are: the pH, chemistry test and patient history.

Crystals pH Chart

Properties of Crystalline Compounds in Urine

Crystals	pH		Solubility Properties	
	Acid	Alkaline	Soluble	Insoluble
Amorphous Urates	+	-	alkali, 60°C	acetic acid
Bilirubin	+	-	chloroform, acid, alkali, acetone	alcohol, ether
Calcium Oxalates	+	±	HCl	acetic acid
Calcium Sulfates	+	-	HCl	
Cholesterol	+	-	chloroform, either, hot alcohol	alcohol
Cystine	+	-	HCl, alkali, especially ammonia	Boiling H_2O, acetic acid, alcohol, ether
Hippuric Acid	+	±	hot H2O, alkali	acetic acid
Leucine	+	-	hot acetic acid, hot alcohol, alkali	HCl
Sodium Urate	+	-	60°C	**Slightly Soluble** - acetic acid
Sulfonamides	+	-	acetone	
Tyrosine	+	-	NH_4OH, HCl, dilute mineral oil	acetic acid, alcohol, ether
Uric Acid	+	-	alkali	alcohol, HCl, acetic acid
X-ray dye	+	-	10% NaOH	
Ammonium Biurates	±	+	60°C, acetic acid, strong alkali, NaOH (ammonia liberated)	
Amorphous Phosphates	-	+	acetic acid	
Calcium Carbonates	-	+	acetic acid (effervescence)	
Calcium Phosphates	-	+	dilute acetic acid	
Triple Phosphates	-	+	dilute acetic acid	

± Crystal may be present at this pH, although they are more common at the other pH.
Graff, Laurine. A handbook of Routine Urinalysis. J.B. Lippencott Company, Philadelphia, PA 1983, pg. 84

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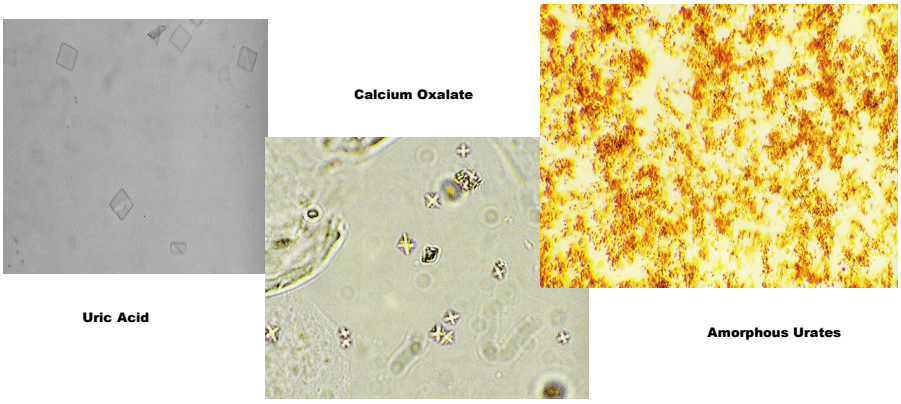
Here is a chart you can use during the case study. It shows you the pH they are commonly found in, what they are soluble or insoluble in.

Common Acidic Crystals



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First we will go over acidic crystals.

Uric Acid Crystals

- Normal and common in urine
- Acidic urine
- Yellow or red-brown in color
- Variety of forms- rhombic, rosettes, wedges, 4-sided plates, barrel, lemon shapes

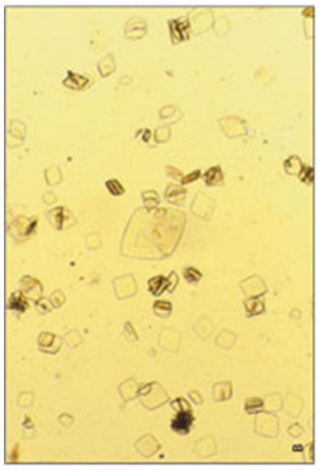




70

First commonly seen acidic crystal is uric acid. Longer urine allowed to stand at RT more these crystals will be seen. Most common shape is the diamond

- **Uric Acid Crystal**
- Soluble with addition of sodium hydroxide.
- Only significant in freshly voided urine.



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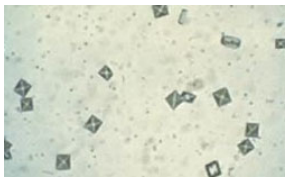
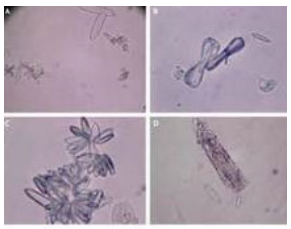
Calcium Oxalate

- Usually in acidic but can be seen neutral or weakly alkaline
- Colorless
- Common shape envelop
- Less common dumbbell, oval and elongated hexagon

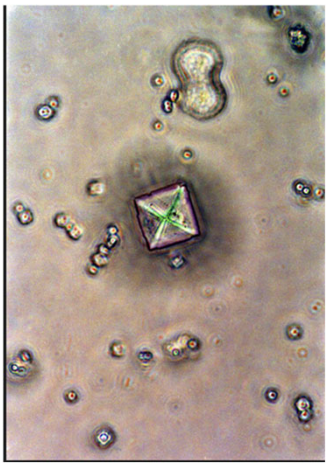




72

Usually seen as a octahedral, envelop shaped square, can see an X on it especially focusing up and down with the fine adjustment. The other shape can be the dumb bell shape

- **Calcium Oxalate Crystal**
- Soluble with addition of hydrochloric acid
- Seen increased with intake of oxalic acid food

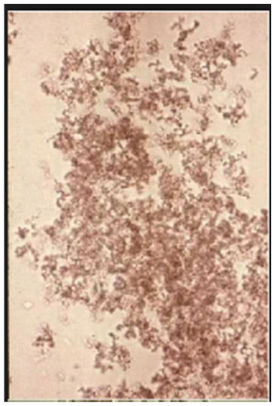


73

Such as tomatoes, apples, asparagus, oranges or carbonated beverages in large quantities.

Amorphous Urates

- Are salts of uric acid
- Found in acid or neutral urines
- Seen in refrigerated urine
- Are pink tan or yellowish
- Appear as amorphous or granular forms
- No clinical significance

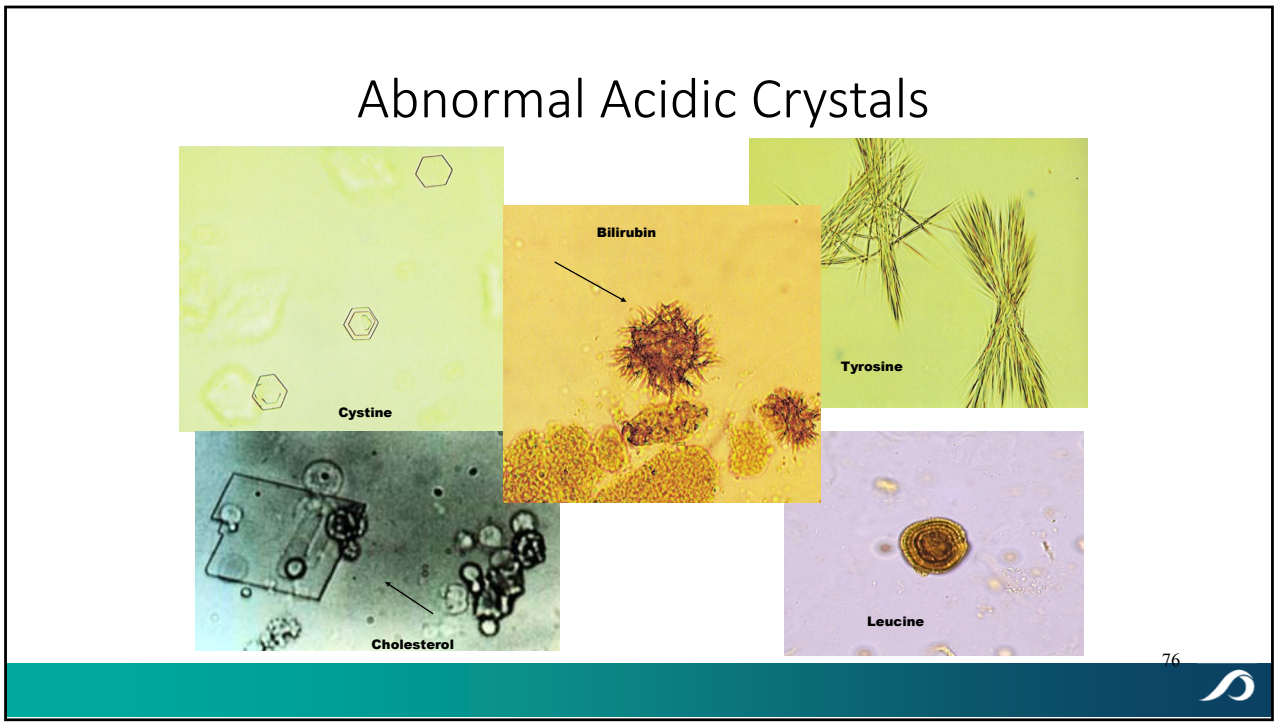


74

- **Amorphous Urates**
- Can obscure other sediment elements
- Can clear with addition of alkali or centrifuging and decanting and replacing with warm saline

75

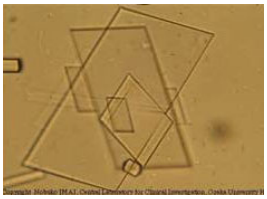
Just be aware that by adding the alkali solution you may dissolve other crystals. I mainly did it to see if there were any bacteria hiding under the granules.



Now we will look at some abnormal acidic crystals.

Cholesterol

- Found in acid and neutral urine
- Regular or irregular transparent plates
- Birefringent in polarized light
- Corner can be notched- stair step crystal
- Abnormal finding



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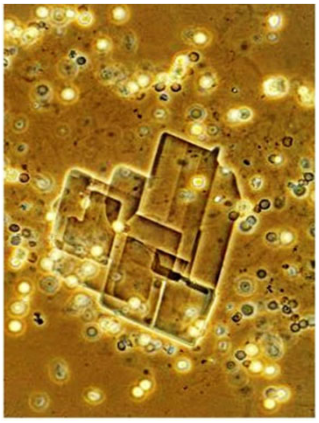
- **Cholesterol Crystals**
- Described as “Stair step crystals
- Soluble in chloroform, ether and boiling alcohol
- Found in various conditions where lipids in kidney.



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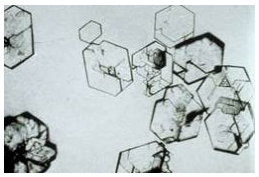
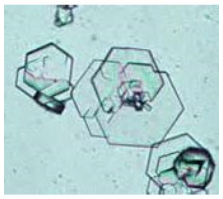
Cystine crystals

- Is an amino acid
- Rarely seen in urine
- Clear, colorless hexagonal plates(Stop signs)
- Acidic urine ≤5.5
- Birefringence absent
- Abnormal crystal





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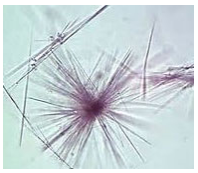
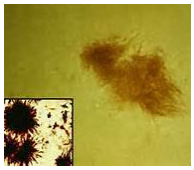
- **Cystine Crystals**
- Can be overlapping
- Can fuse into rosette
- Soluble in hydrochloric acid, sodium hydroxide and ammonium hydroxide
- Seen in cystinuria

80

Cystinuria is an inherited condition. These crystals are the most frequent cause of kidney stones in children

Tyrosine Crystals

- Rare, always abnormal
- Form clusters of silky needle-like structures
- Colorless or black on focusing
- Acidic urine
- Increase after refrigeration

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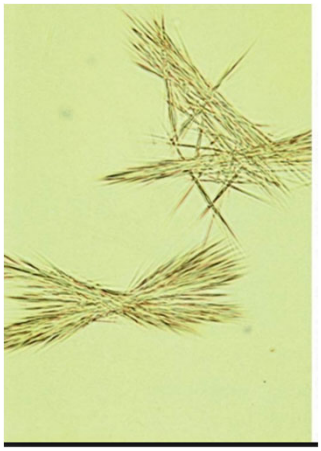
- **Tyrosine Crystals**
- Insoluble in alcohol or ether
- Soluble in dilute HCL
- Orange color with nitrosonaphthol confirmatory
- Tyrosiuria occurs with liver disease
- What dipstick test positive
  - ➢Bilirubin



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Can be seen in tyrosinemia and certain liver disorders in which amino acid metabolism is impaired.

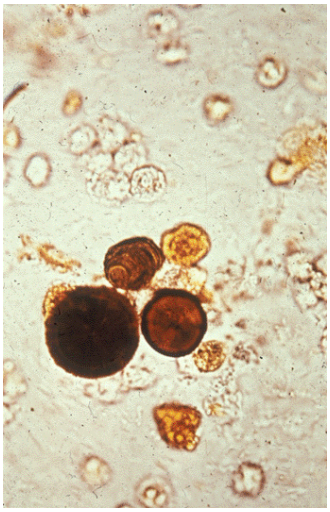
Leucine Crystals

- Acidic urine
- Spheroids with concentric striations
- Dense
- Highly refractile
- Yellowish brown
- Can be oily looking

83

Often seen in same urine with Tyrosine crystals for same clinical conditions

- **Leucine Crystals**
- "pseudo" Maltese cross
- Seen severe liver disease
- Hereditary amino acid metabolic disorders
- Can be seen with tyrosine crystals
- What dipstick test can be positive?
  - ➢Bilirubin



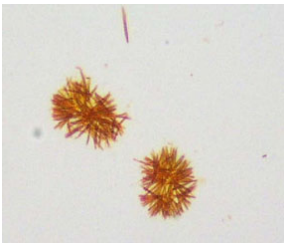
84

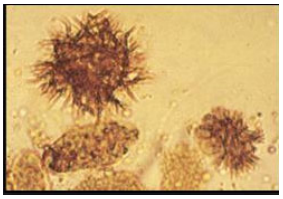
When you polarized

can see pseudo-Maltese cross appearance. Seen in liver disease, "Maple Syrup Urine Disease is a significant crystal.
Just as with tyrosine these crystals may be seen in liver disorders in which amino acid metabolism is impaired.

Bilirubin Crystals

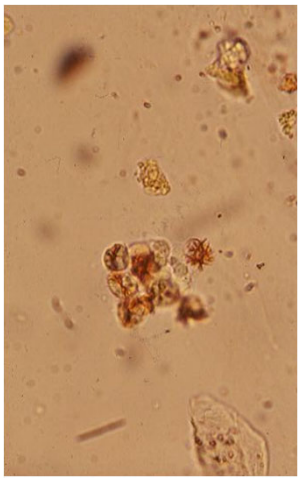
- Acidic urine
- Yellowish brown granules
- Can also seen cluster of needles
- Abnormal finding





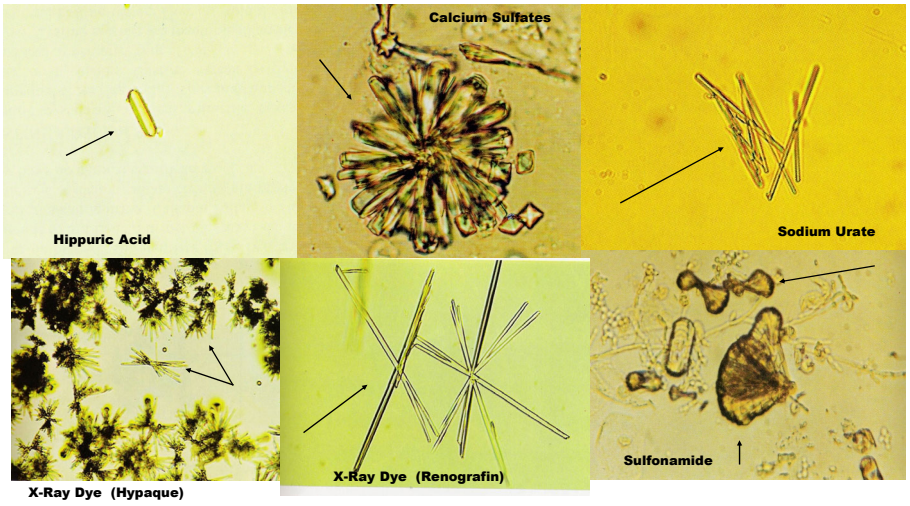
85

- **Bilirubin Crystals**
- Soluble in acetic and hydrochloric acids
- Seen in diseases that exhibit jaundice
- What dipstick test positive?
  - Bilirubin



86

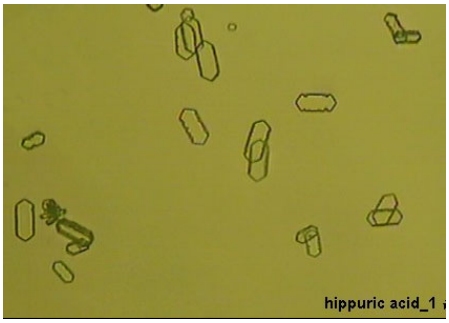
Uncommon Acid Crystals



87

Hippuric Acid Crystals

- Acidic urine or neutral pH
- yellow-brown or colorless elongated prisms or plates
- Sometimes thin resemble needles



88

- **Hippuric Acid Crystals**
- Soluble in Ether
- No clinical significance but can be seen in ethylene glycol intoxication
- Can be confused with triple phosphate crystals

89

Produces in the normal subject after the ingestion of fruits and vegetables that contain large quantities of benzoic acid.

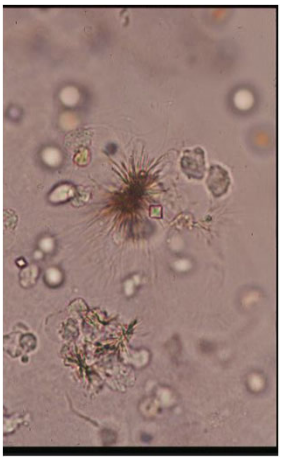
Calcium Sulfate Crystals

- Acidic urine or neutral pH
- Long, thin and colorless needles or prisms.

- **Calcium Sulfate Crystals**
- Rarely seen in urine
- Appearance identical to Calcium phosphate in its prism form.
- No clinical significance

Sodium Urate Crystals

- Acidic urine
- Small, brown, needle-like crystals
- Can occur in sheaves or clusters



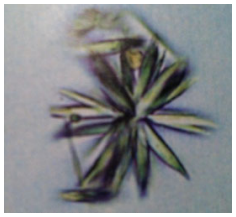
92

- **Sodium Urate Crystals**
- Soluble in 10% acetic acid
- Rarely seen in urine
- No significance when seen in urine

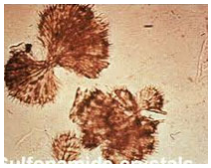
93

Sulfonamide Crystals

- Acidic urine
- Can be seen following sulfonamide therapy
- Soluble in alkaline pH



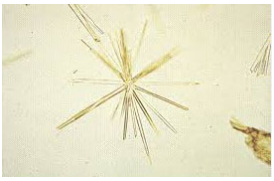
- **Sulfonamide Crystals**
- Appearance depends on type of sulfa compound
- Transparent bars or needles
- Hexagonal plate or shock of wheat
- Arrowheads or flower petal



95

X-Ray Dyes

- Acidic urine
- Flat needles
- Sheaves accompanied by round globules
- Variable forms
- Sometimes mistaken for tyrosine



96

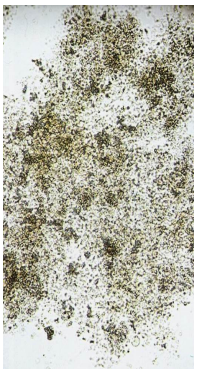
- **X-Ray Dyes**
- Soluble with 10% Sodium Hydroxide
- Will cause high specific gravity by refractometer.
- Should confirm administration of contrast media

97

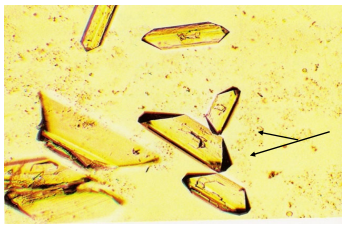
This is a polarized picture of these crystals. Way can tell from tyrosine is the specific gravity will be high

Common Alkaline Crystals

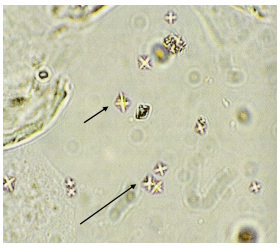
Amorphous Phosphates



Triple Phosphate



Calcium Oxalate

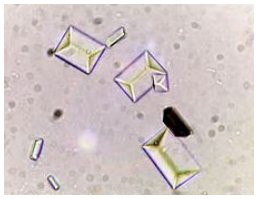


98

We will now look at the common alkaline crystals. As you can see Calcium Oxalate is listed here. As previously mentioned it can appear in slightly alkaline or neutral urines.

Triple Phosphate

- Also know as Ammonium Magnesium Phosphate
- Colorless
- 3-6 sided prism shaped
- Resembles “coffin lid”
- Less common as colorless sheets, flakes, flats, ferns or leaf form



99

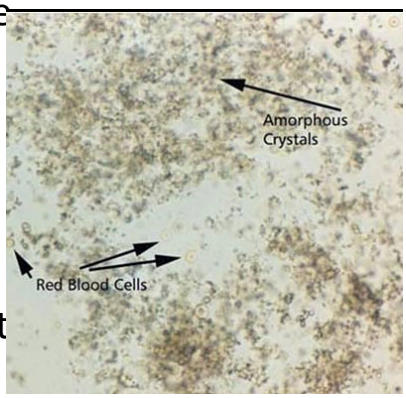
- **Triple Phosphate**
- Present in alkaline or neutral urine
- Birefringent under polarized light
- Seen highly alkaline urine with urea-splitting organisms mostly Proteus species.

100

If seen in fresh
urine may be due to urea-splitting microorganism possibly secondary to urinary tract obstruction or stasis -kidney stone formation

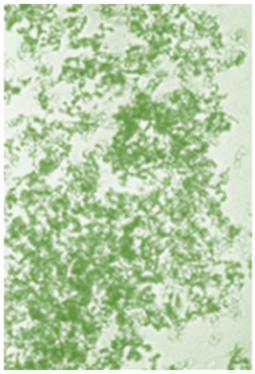
Amorphous Phosphates

- Appear in neutral or alkaline urine
- Fine, colorless or slightly brown granules
- Tend to aggregate into groups or clumps
- Can obscure other sediment



101

- **Amorphous Phosphates**
- Will be more prominent in refrigerated urine.
- Can impart a cloudy to turbid appearance of urine
- Soluble with acetic Acid

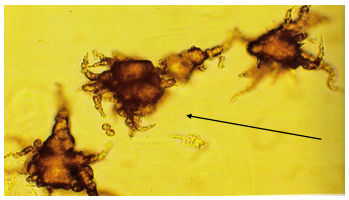


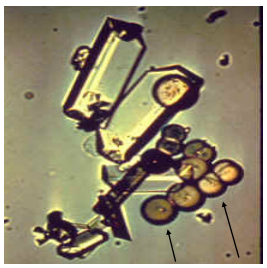
102

Must confirm RBC present before introducing acetic acid because it will lyse the RBC too

Uncommon Alkaline Crystals

Ammonium Biurate





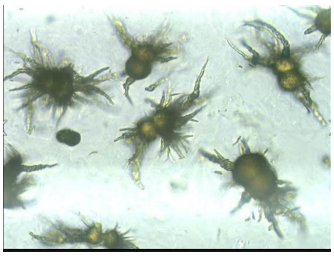
Calcium Carbonate

Calcium Phosphate

103

Ammonium biurate

- Neutral or alkaline pH
- Yellow-brown
- Spheres with radial or concentric striation
- Irregular projections/thorns
- Resemble scorpion

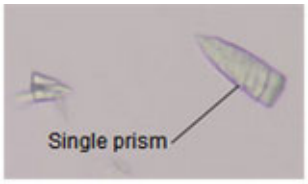


104

- **Ammonium Biurate**
- Can be seen in normal urine
- If in urine with high pH indicates old/poorly preserved urine

Calcium Phosphate Crystals

- Urine with alkaline or neutral pH
- Can have granular, amorphous or crystalline forms
- Most common is wedge-shaped prism



106

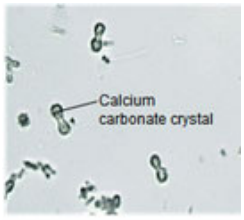
- **Calcium Phosphate Crystals**
- Rarely seen in urine
- Appearance identical to Calcium Sulfate in its prism form.
- No clinical significance

107

Tell them from Calcium Sulfate with the pH. Can form renal calculi and tend to irritate the urinary tract when formed within the body.

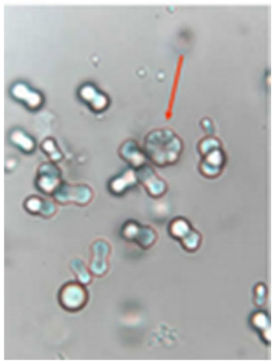
Calcium Carbonate Crystals

- Urine with alkaline pH
- Appear as granules or small colorless dumbbells
- Not clinically significant.
- Sometimes confused with bacteria



108

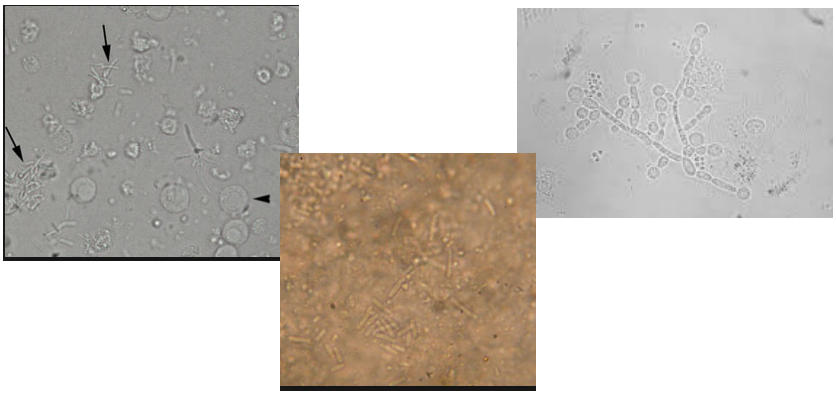
- **Calcium Carbonate Crystals**
- Can be dissolved with acetic or hydrochloric acid that will cause an effervescent response
- Can be seen after ingestion of large amount of vegetables



109

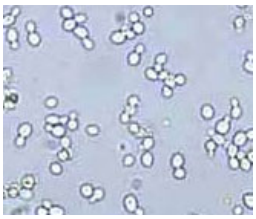
The effervescent is due to release of carbon dioxide.

Bacteria and Fungi



Yeast/fungi, extracellular

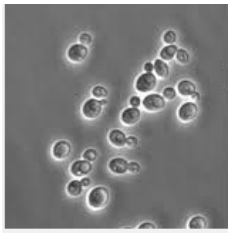
- Usually ovoid and colorless
- Refractile appearance
- Can be branching or hyphae
- Can be confused with RBC or fat globules
- Can be contaminant but more likely a pathogen than bacteria

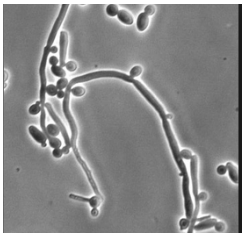


111

To differentiate from RBC the yeast will have an ovoid shape and vary in size where RBC will be round and same size

- **Yeast/fungi**
- Urinary tract infection if increase WBC seen
- Can have budding and hyphal forms if allowed to sit before analysis
- What dipstick test be positive?
  - Nitrites
  - Leukocyte Esterase





112

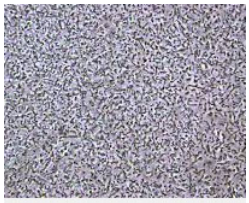
Leukocyte esterase if WBC present

Bacteria, extracellular

- Not normally seen in urine
- Can be a contaminate
- If seen with increased WBC most likely infection.
- Shape depends on type of bacteria.
- If suspected as pathogen should be sent to microbiology

113

- **Bacteria**
- Most common contaminate is E coli
- What dipstick test are positive?
  - Nitrite
  - Leukocyte Esterase
  - Protein



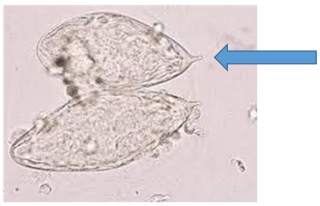
114

The positive test on dipstick depend on if WBC seen and the amount seen in urine. If in large number can produce a cloudy appearance

Parasites

Parasites

- Parasites are not normally seen in urine.
- Schistosoma hematobium is parasite infection seen in Africa and Southwestern Asia countries.
- Distinguished from S mansoni and S japonicum by distinct terminal spine
- A drop-in parasite can be pubic lice

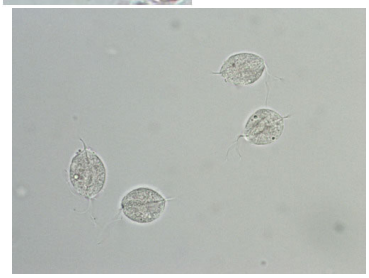


116

Here are two that might be seen.

Trichomonas vaginalis

- Exception is Trichomonas vaginalis
- Can originate from the genitourinary tract
- Can be fecal contamination
- Easily identified
- Spheric or pear-shaped
- Pair of flagella



117

Will move in a rapid, jerking motion with gentle rotation. Usually accompanied with increase PMN's

Quality Assurance

The Quality Assurance Program Must:

- Assess the effectiveness of the lab's policies and procedures.
- Identify and correct problems.
- Assure the accurate, reliable, and prompt reporting of test results.
- Assure the adequacy and competency of the staff.
- Must initiate corrective action for problems.
- All aspects of quality assurance activities must be documented.

119

As the saying goes, if it is not written down, it did not happen.

Quality Assurance includes

- Pre-analytical Process
- Analytical Process
  - Internal Quality Control
  - External Quality Assessment
- Post-analytical Process

Pre-Analytical Process

- What type of specimen.
- How was it collected.
- Includes prompt processing when possible.
- Storage if unable to process within 2 hours
- Most important part is the acceptability of the specimen.
- Includes criteria for rejection of specimens

121

- What type of specimen is it – Random, first morning void, two-hour postrandial (2 hour after eating), 24 hour collection
- How the sample was collected. – catheterization, midstream (clean catch)
- When unable to perform testing specimen should be properly preserved either through refrigeration or preservative tubes.
- Should have acceptability policy for samples
- Rejection policy.

Analytical Process

- Should include the same measured aliquot.
- Urine should be centrifuged prior to microscopic exam at same speed and time
- Strongly suggest the use of coverslips.
- Urines should be scanned on low power but counted on high-power.
- Can include use of contrast or polarized microscope.
- Also can use stain to help visualize structures.

122

In the analysis portion of the test.

- Consistency needs to be used. Should include the same measured aliquot of urine when possible,
- For consistent results should be centrifuged same speed and time.
- Use coverslips- provide consistency of observations.
- Start with low power but then changed to high-power for confirmation of sediment
- The same magnification should be used for all reporting.
- A phase contrast and/or polarizing microscope can enhance structures in urine sediment such as cells, cast and crystals.
- Also the use of stains can help visualize structures

Commercial Controls

- Should include a positive and negative control.
- Include Lot-to-Lot verification.
- Run at least once per shift.
- All controls documented for acceptability.
- Have policy for “out-of-control” results.

123

There are commercial control should be used.
Any unexpected control results should be identified, and corrective action taken before patient analysis

External Quality Assurance

- Should participate in a EQA program.
- Help to detect inconsistency in reporting.
- Determines the performance of individual laboratories.
- Monitors laboratory continuing performance.

Post Analytical Process

- Results reported using a standard format.
- Questionable results should be confirmed.
- Laboratory should include reference material for difficult and/or doubtful findings.
- Should include competency testing on personnel.

125

This is the resulting portion of the testing.

- This ensures that all of the personnel are reporting in the same manner
- Policy for confirmation by supervisor/pathologist
- A library of textbooks and atlas should be available for confirmation of sediment
- Competency testing should include all aspects of testing from the processing the specimen to the resulting.

Questions??

Case History Answer Sheet

- 1. _____
- 2. _____
- 3. _____
- 4. _____
- 5. _____
- 6. _____
- 7. _____
- 8. _____
- 9. _____
- 10. _____

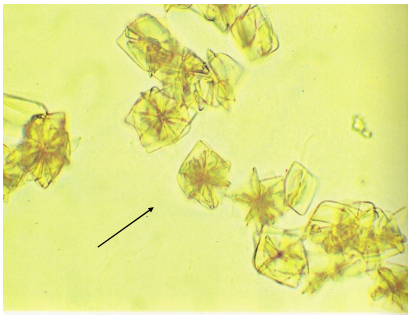
127

Case History - 1

- 24-year-old female patient. Asymptomatic UA during a physical exam.
- Rapid Chemistry
  - SG = 1.016
  - pH = 6.0
  - Blood, Protein, Glucose, & Leukocyte Esterase = Negative

128

Case History - 1



Uric Acid

- 24-year-old female patient. Asymptomatic UA during a physical exam.
- Rapid Chemistry
  - SG = 1.016
  - pH = 6.0
  - Blood, Protein, Glucose, & Leukocyte Esterase = Negative

129

Case History - 2

- 48-year old male found incoherent and hospitalized.
- Rapid Chemistries
  - Cloudy urine
  - Blood 2+
  - Protein 4+
  - Nitrite & Leukocyte Esterase = Positive

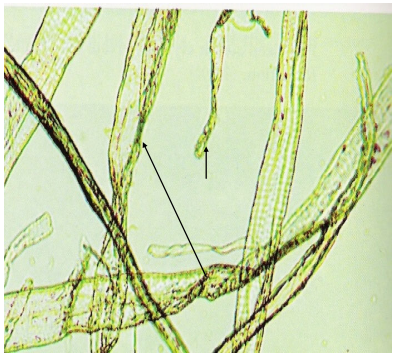
130

Case History - 2

Waxy Cast

- 48-year old male found incoherent and hospitalized.
- Rapid Chemistries
  - Cloudy urine
  - Blood 2+
  - Protein 4+
  - Nitrite & Leukocyte Esterase = Positive

Case History - 3



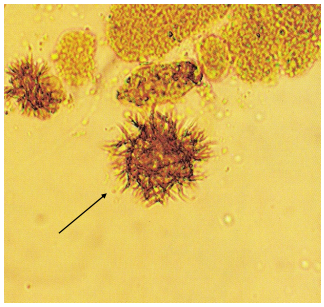
- 63-year old male with lower back pain.
- Rapid Chemistries
  - pH 5.0
  - Nitrite = Positive
  - Protein, Blood, Leukocyte Esterase, Glucose, Ketones = Negative

Case History - 3

Fibers

- 63-year old male with lower back pain.
- Rapid Chemistries
  - pH 5.0
  - Nitrite = Positive
  - Protein, Blood, Leukocyte Esterase, Glucose, Ketones = Negative

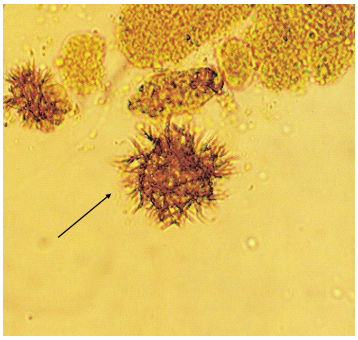
Case History - 4



- 45-year old male with chronic hepatitis.
- Rapid Chemistries
  - Specific Gravity = 1.015
  - pH 5.5
  - Bilirubin = Positive
  - Protein = 3+
  - Leukocyte Est. = Positive
  - Nitrite, Blood, Glucose, Ketones = Negative

134

Case History - 4

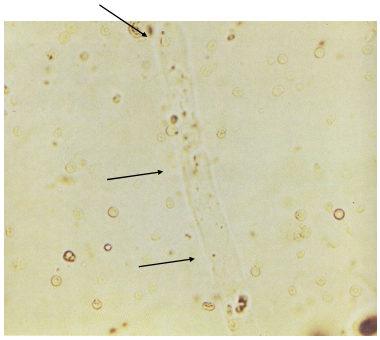


Bilirubin

- 45-year old male with chronic hepatitis.
- Rapid Chemistries
  - Specific Gravity = 1.015
  - pH 5.5
  - Bilirubin = Positive
  - Protein = 3+
  - Leukocyte Est. = Positive
  - Nitrite, Blood, Glucose, Ketones = Negative

135

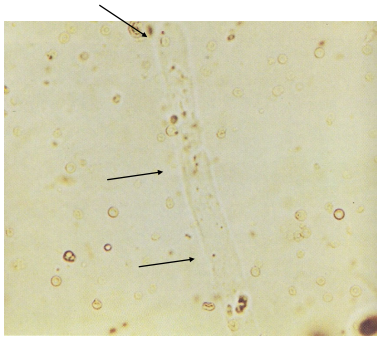
Case History - 5



- 19-year old female. Asymptomatic with UA during a physical exam.
- Rapid Chemistries
  - pH 6.5
  - Blood = 1+
  - Protein = Trace
  - Leukocyte Est., Nitrite, Glucose, Ketones = Negative

136

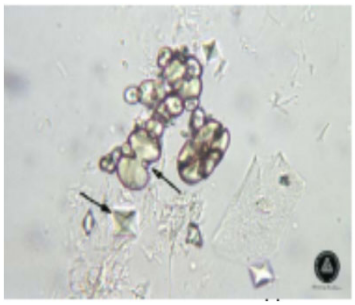
Case History - 5



Hyaline Cast

- 19-year old female. Asymptomatic with UA during a physical exam.
- Rapid Chemistries
  - pH 6.5
  - Blood = 1+
  - Protein = Trace
  - Leukocyte Est., Nitrite, Glucose, Ketones = Negative

Case History - 6



- 25-year old female admitted for multiple substance abuse.
- Rapid Chemistries
  - Cloudy
  - pH 6.5
  - Protein = Trace
  - Leukocyte Est., Nitrite, Blood, Glucose & Ketones = Negative

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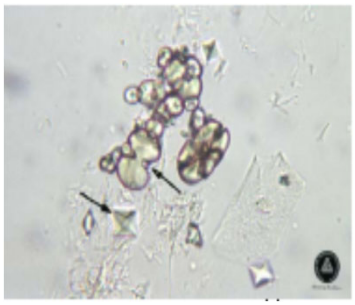
Case History - 6



Calcium Oxalate

- 25-year old female admitted for multiple substance abuse.
- Rapid Chemistries
  - Cloudy
  - pH 6.5
  - Protein = Trace
  - Leukocyte Est., Nitrite, Blood, Glucose & Ketones = Negative

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Case History - 7

- 52-year old female admitted for renal disease.
- Rapid Chemistries
  - pH 5.0
  - Protein = 3+
  - Specific Gravity = 1.030
  - Leukocyte Est., Nitrite, Blood, Glucose, Ketones = Negative

Case History - 7

Waxy Cast

- 52-year old female admitted for renal disease.
- Rapid Chemistries
  - pH 5.0
  - Protein = 3+
  - Specific Gravity = 1.030
  - Leukocyte Est., Nitrite, Blood, Glucose, Ketones = Negative

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Case History - 8

- 71-year old male with alcoholic cirrhosis and esophageal bleeding.

Rapid Chemistries

- pH 5.0
- Specific Gravity = 1.030
- Protein = 2+
- Blood = 2+
- Bilirubin = 3+
- Leukocyte Est. = Negative
- Nitrite & Glucose = Negative

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Case History - 8

Cellular Cast,RBC

- 71-year old male with alcoholic cirrhosis and esophageal bleeding.

Rapid Chemistries

- pH 5.0
- Specific Gravity = 1.030
- Protein = 2+
- Blood = 2+
- Bilirubin = 3+
- Leukocyte Est. = Negative
- Nitrite & Glucose = Negative

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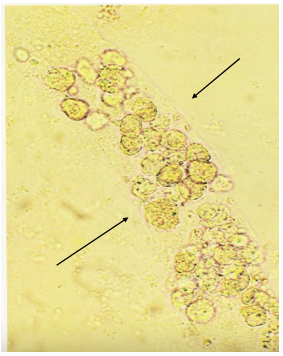
Case History - 9



- 20-year old female with acute pyelonephritis (renal Infection).
- Rapid Chemistries
  - pH 5.0
  - Nitrite = Positive
  - Protein = 2+
  - Leukocyte Esterase = Positive
  - Blood, Bilirubin, Ketones & Glucose = Negative

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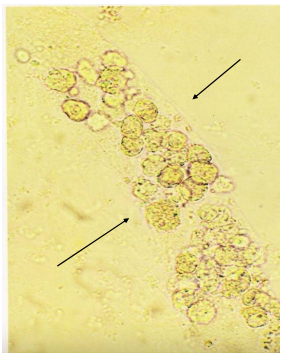
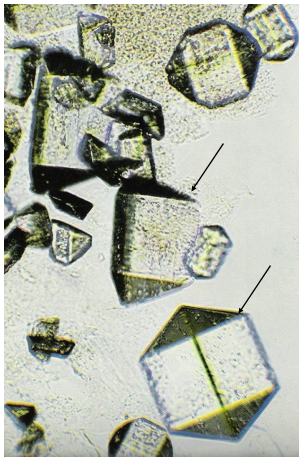
Case History - 9



Cellular Cast, WBC

- 20-year old female with acute pyelonephritis (renal Infection).
- Rapid Chemistries
  - pH 5.0
  - Nitrite = Positive
  - Protein = 2+
  - Leukocyte Esterase = Positive
  - Blood, Bilirubin, Ketones & Glucose = Negative

Case History - 10



- 20-year old male. Asymptomatic with UA performed during a physical exam.
- Rapid Chemistries
  - pH 7.5
  - Protein = Trace
  - Leukocyte Esterase, Nitrite, Blood, Bilirubin, Ketones & Glucose = Negative

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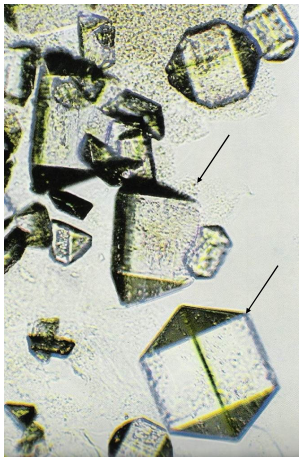
Case History - 10



Triple Phosphate

- 20-year old male. Asymptomatic with UA performed during a physical exam.
- Rapid Chemistries
  - pH 7.5
  - Protein = Trace
  - Leukocyte Esterase, Nitrite, Blood, Bilirubin, Ketones & Glucose = Negative

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Questions??

Thank You!

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