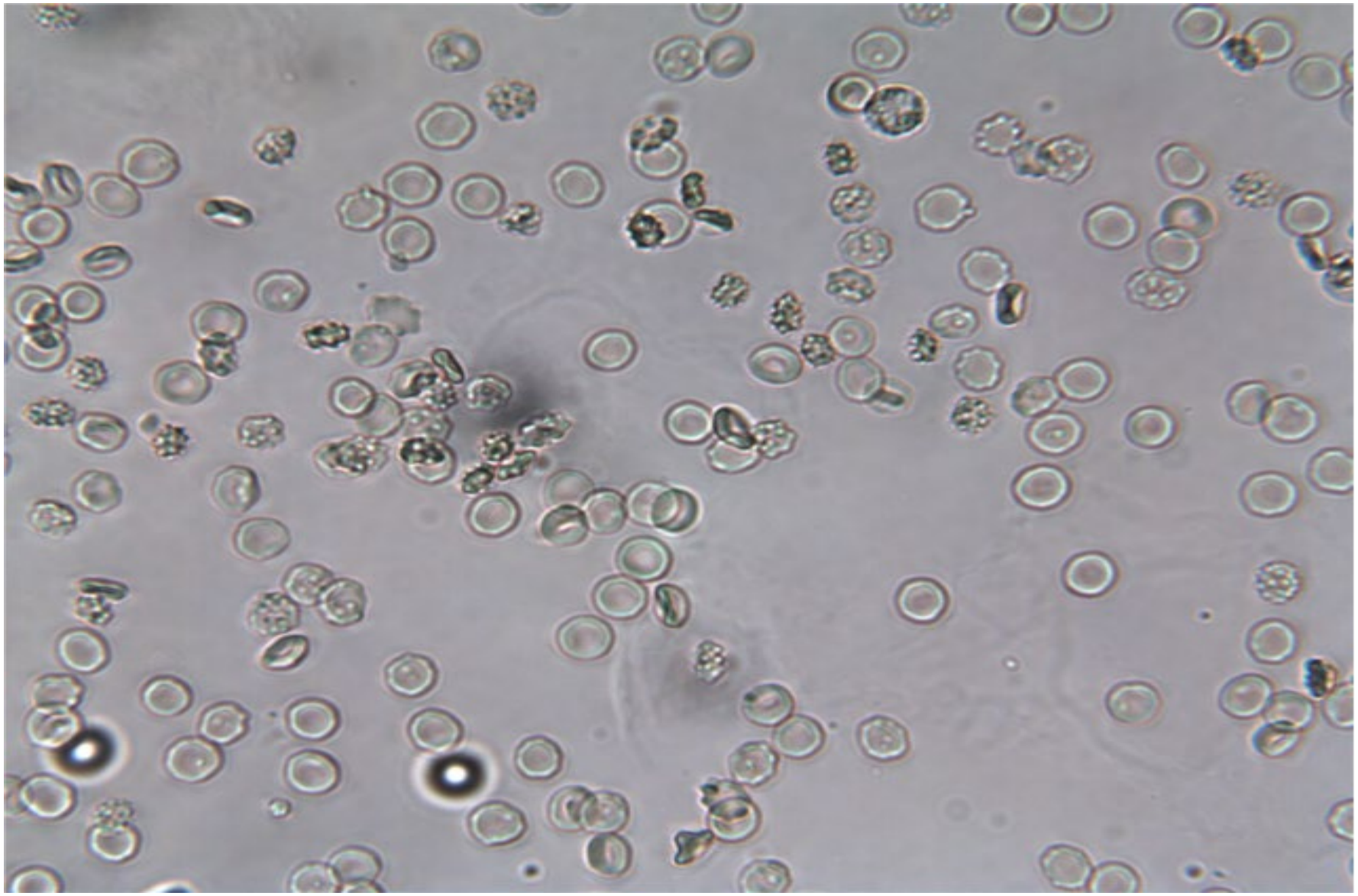
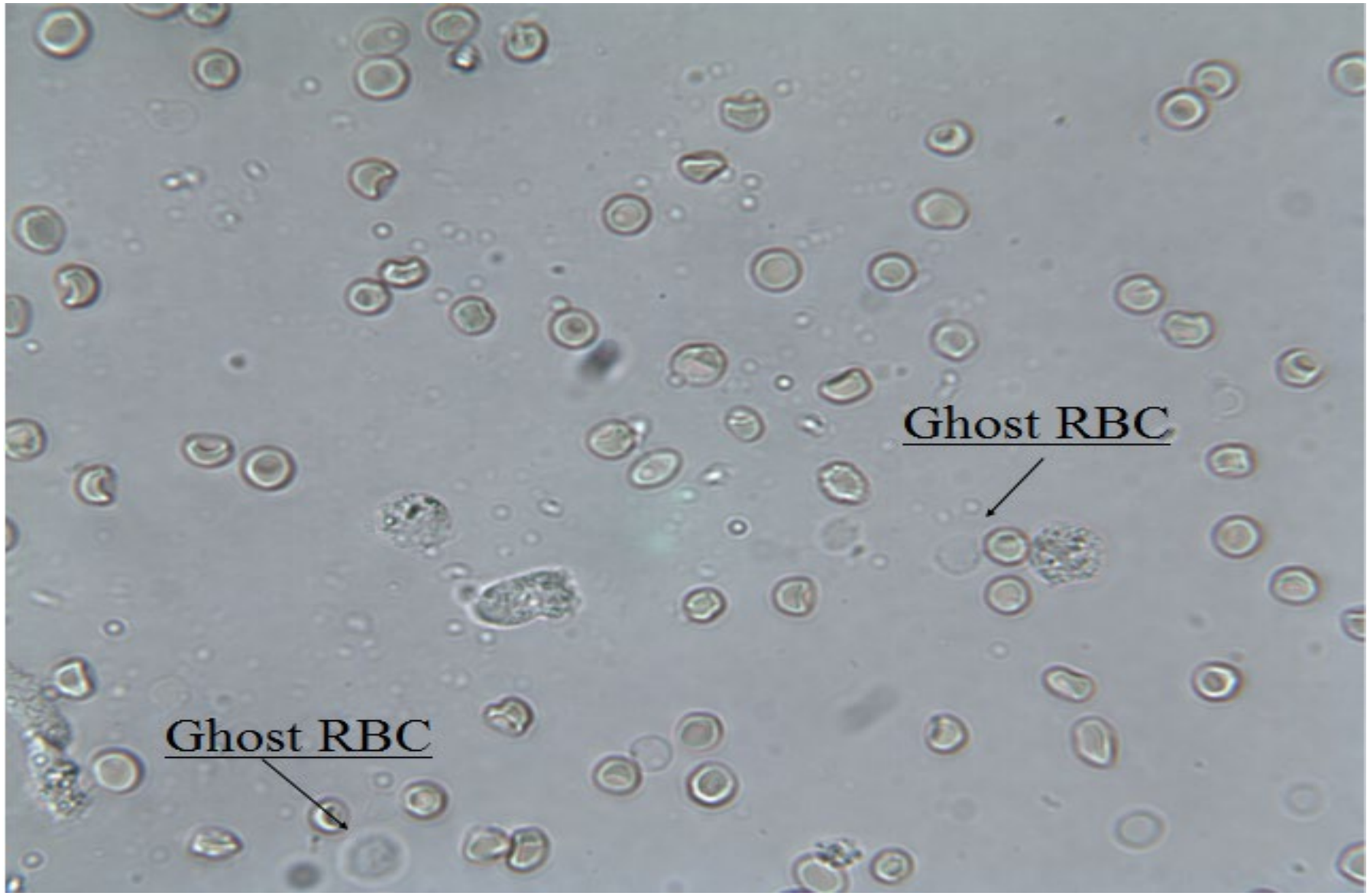
# Urine Microscopic Examination

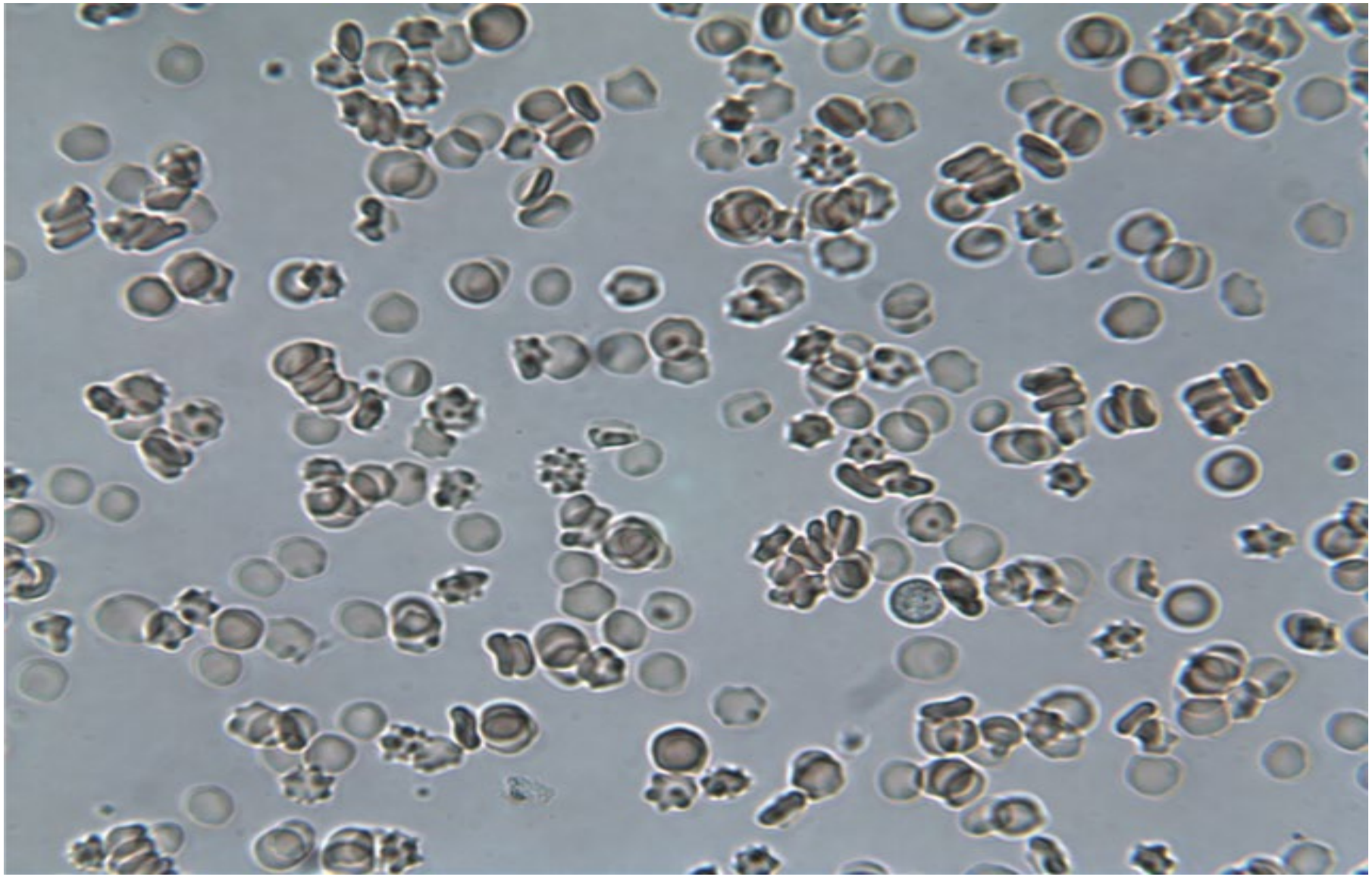
요침사 판독



**Concentrated urine: RBCs crenate**




**Dilute urine: RBCs will swell**



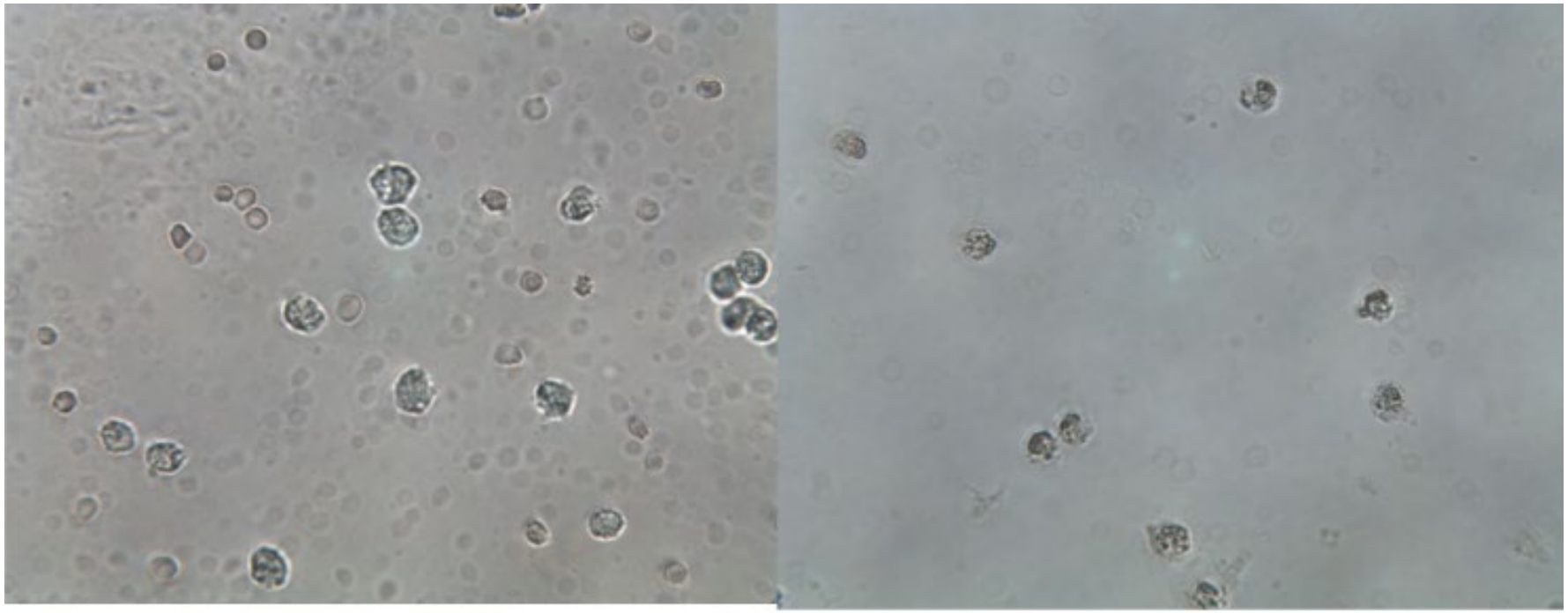
**RBC's showing rouleaux**

# RBC can resemble:

- Yeast
- Oil droplets, air bubbles
- Calcium oxalate crystals, oval form
- In concentrated urine, RBC will crenate and resemble WBC

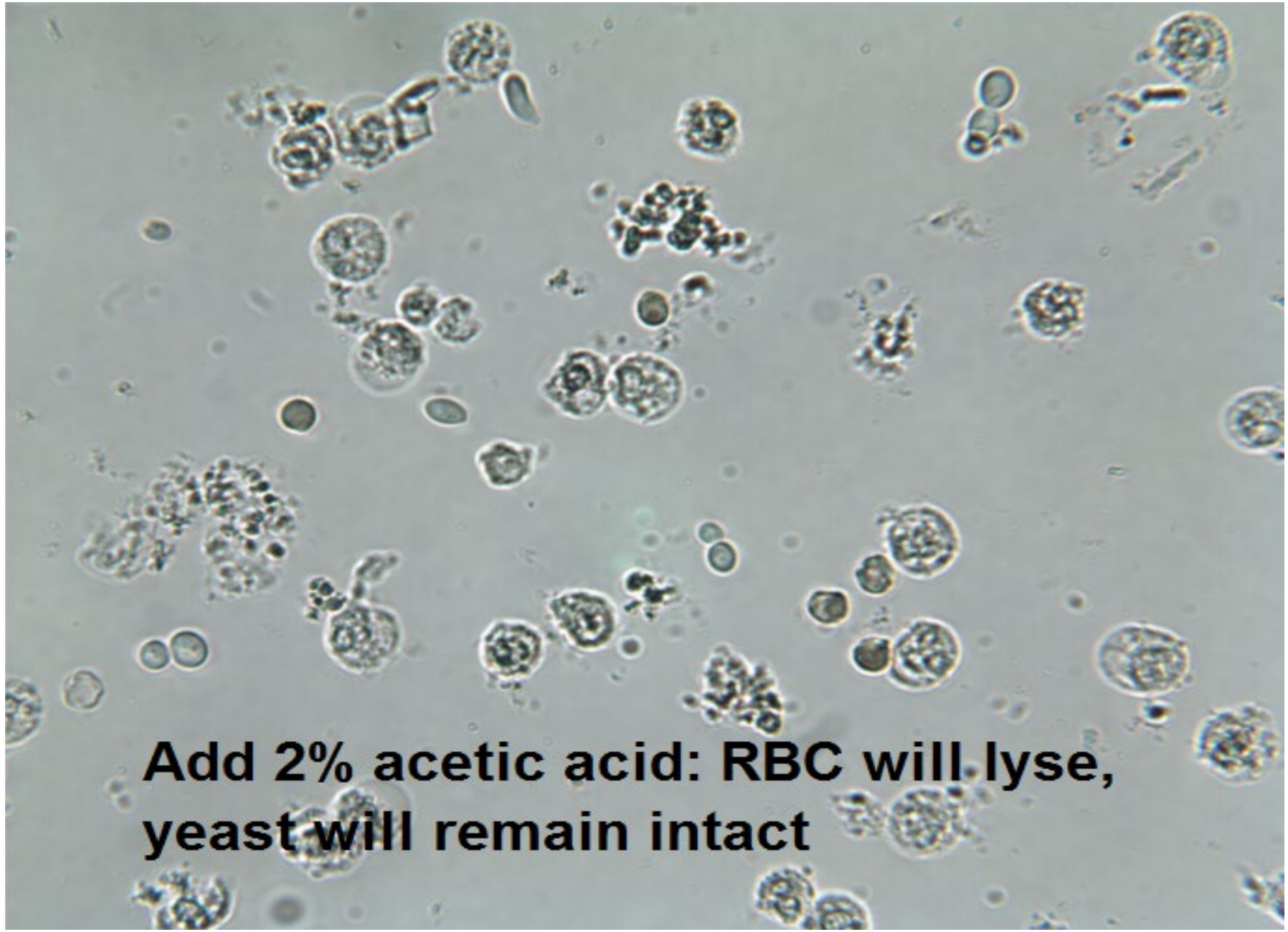
# Acetic Acid, 2%

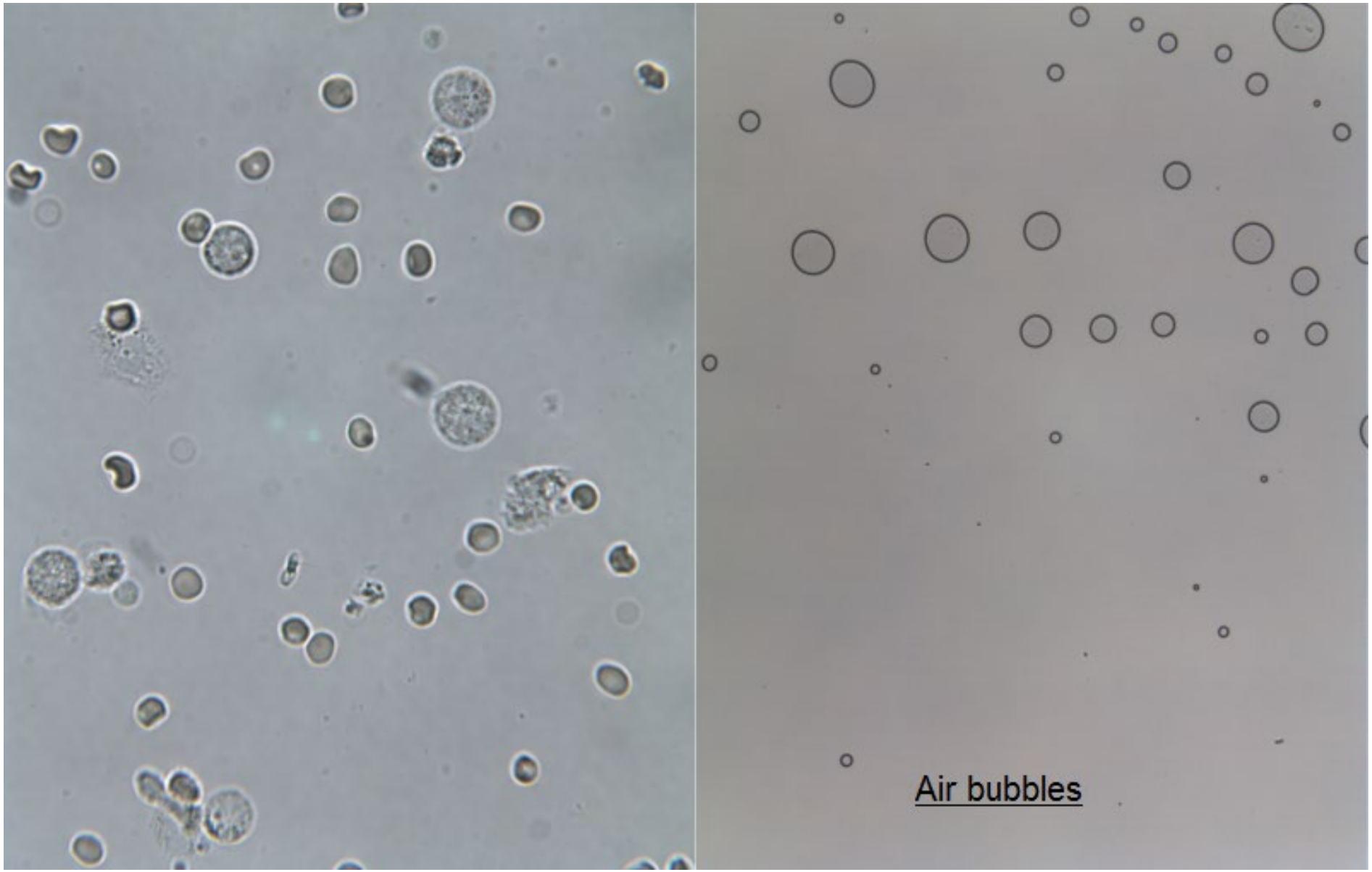
- Enhances nuclear structure of WBC
- Differentiates RBC from yeast (RBC will hemolyze)

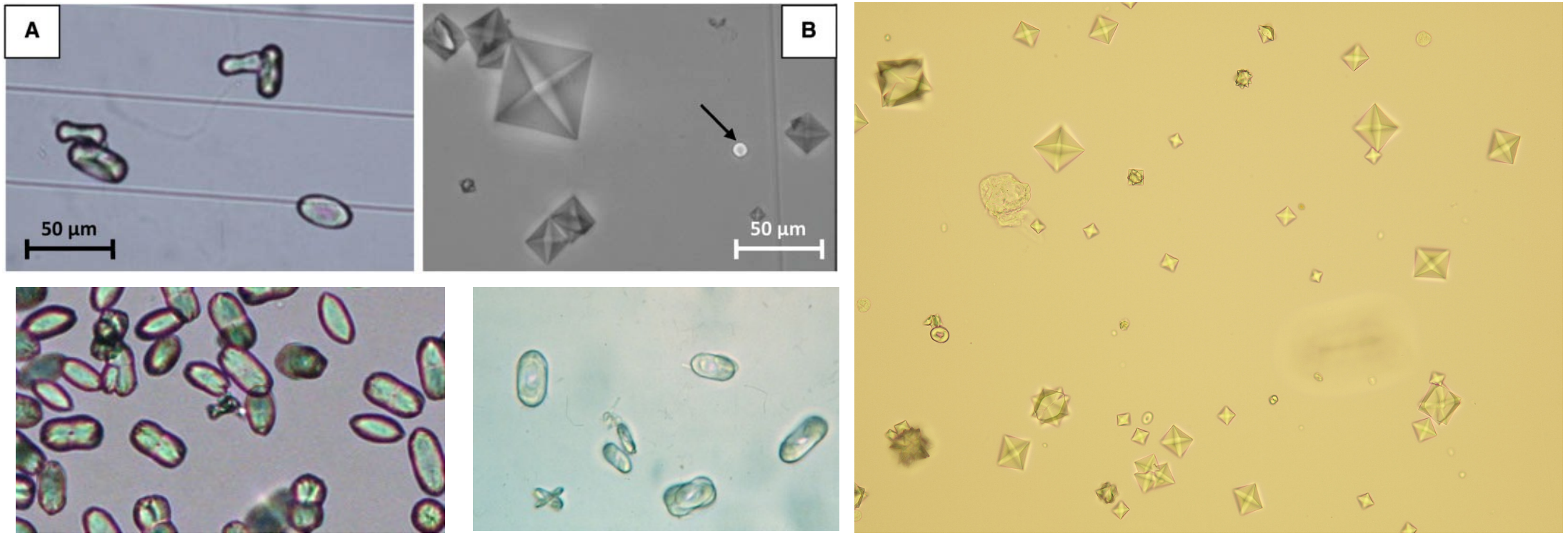


Before Acetic Acid was added

After Acetic Acid was added

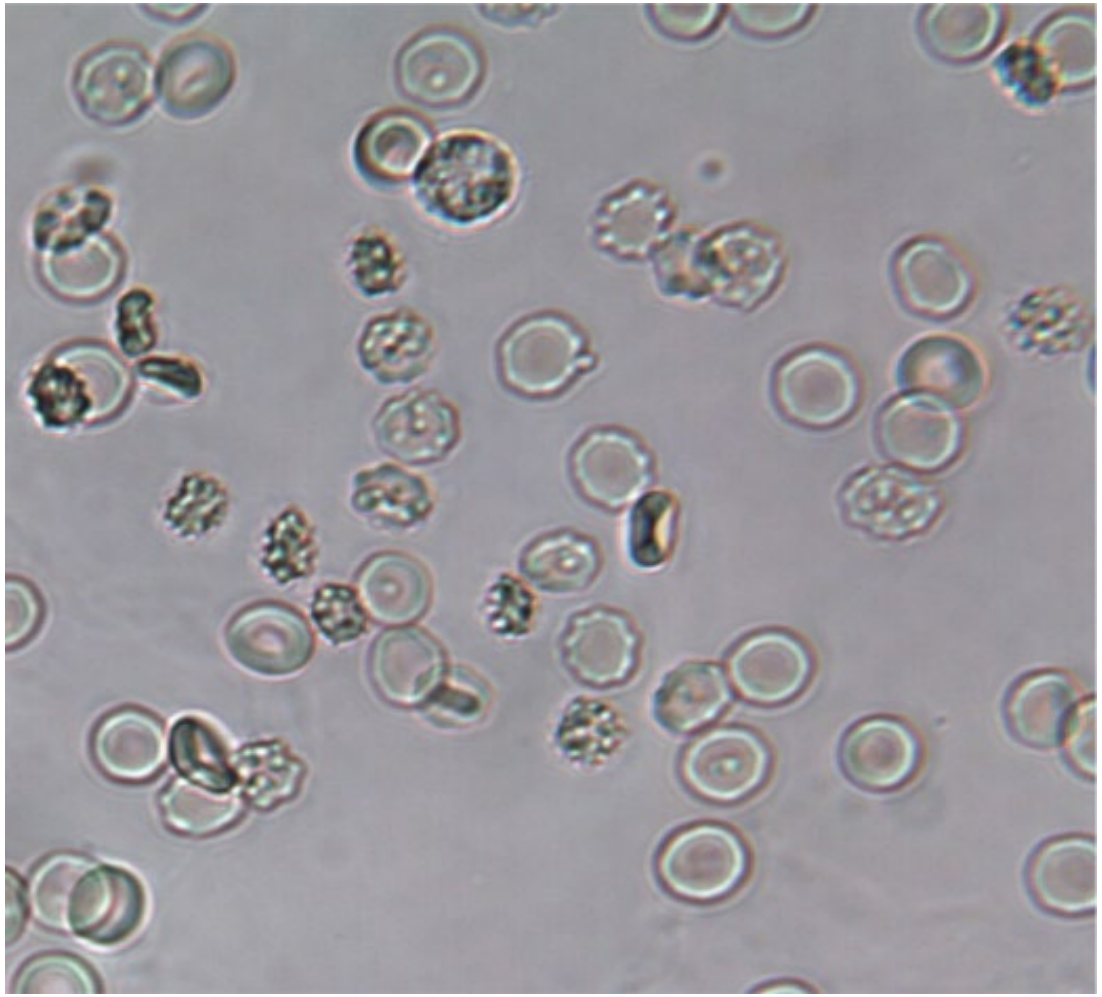

Add 2% acetic acid: RBC will lyse,
yeast will remain intact


Air bubbles




# Calcium oxalate crystals

(oval form, Calcium oxalate monohydrate)



**Crenated RBC can resemble WBC**

# RBC Correlation

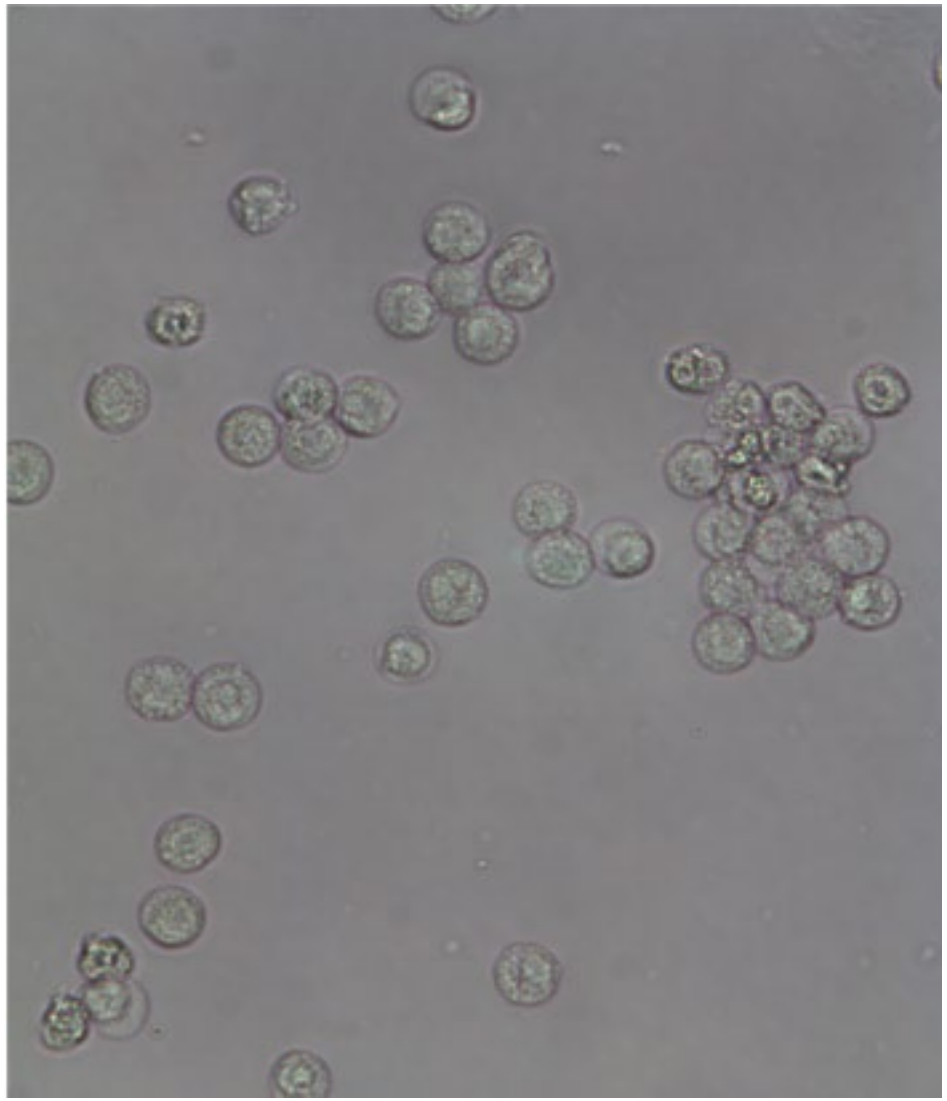
- **Correlate microscopic evaluation with :**
  - **Physical exam**
    - Color
    - Clarity
  - **Chemical exam**
    - Positive reagent strip
    - Ascorbic acid: causes false negative result
    - Myoglobin: causes false positive result

# WBC: leukocytes

- WBC in urine: leukocyturia
- Indicates infection (bacterial, non-bacterial)
- Normal: 0-5 WBC/hpf
- Neutrophil predominant type of WBC found in urine

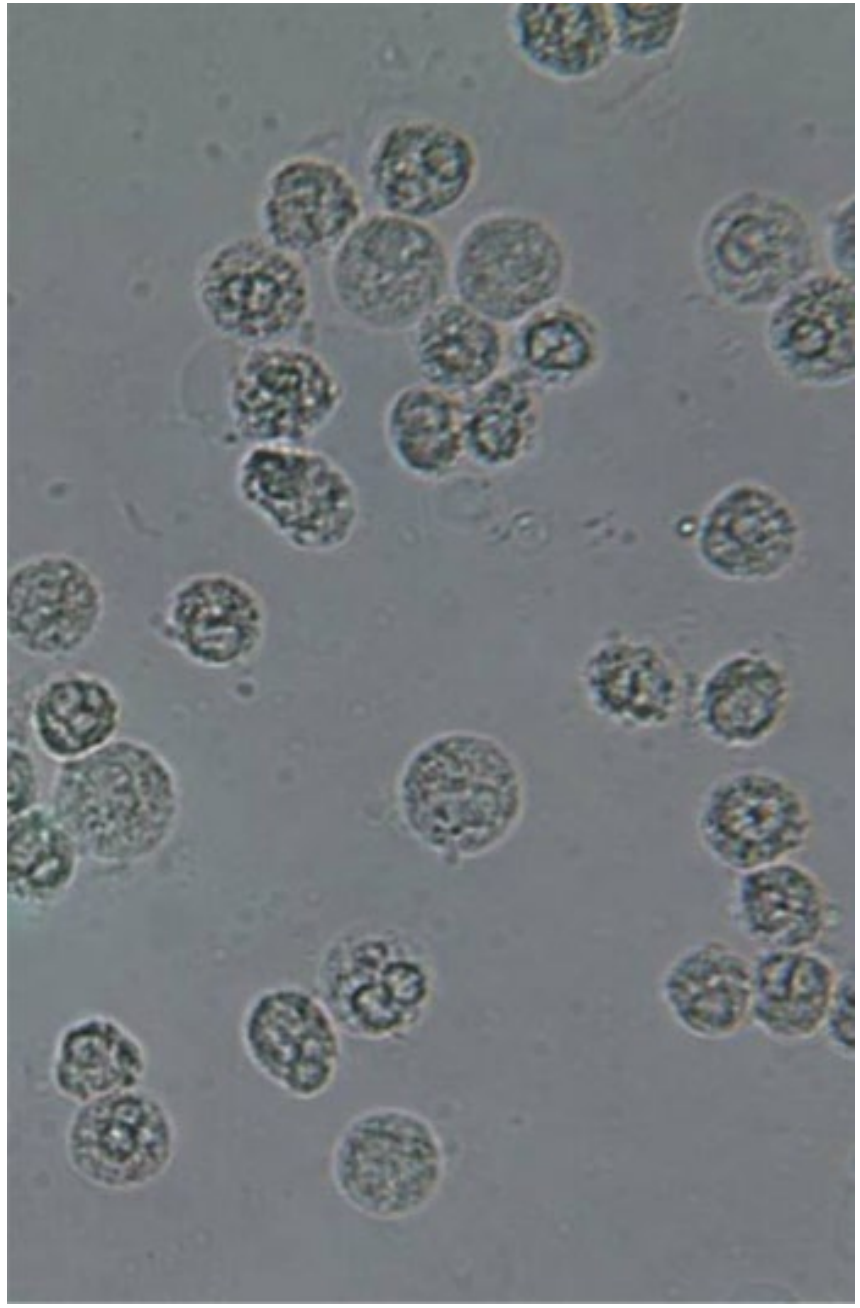
# WBC: leukocytes

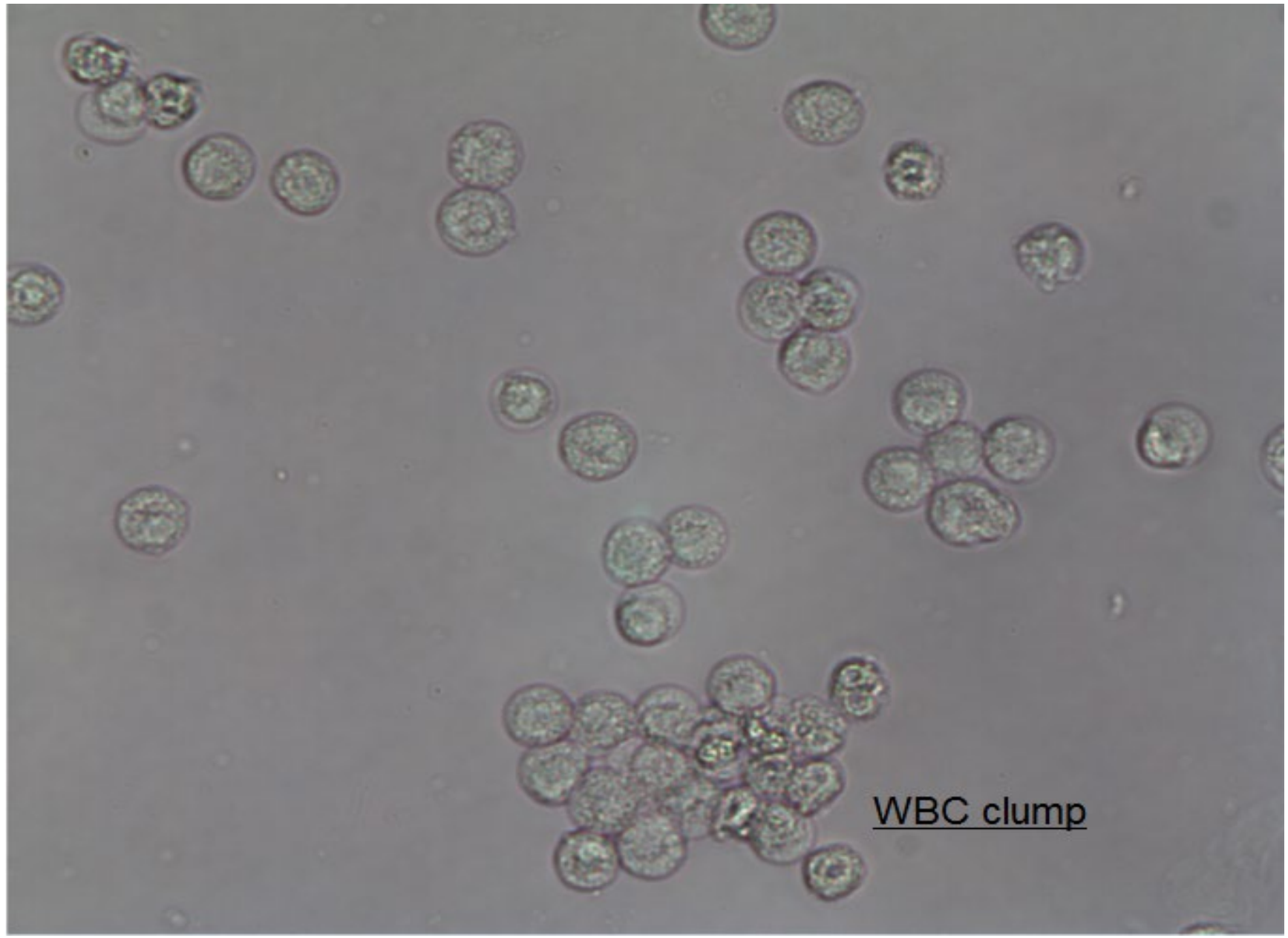
- Spherical
- Approximately
  2x larger
  than RBC

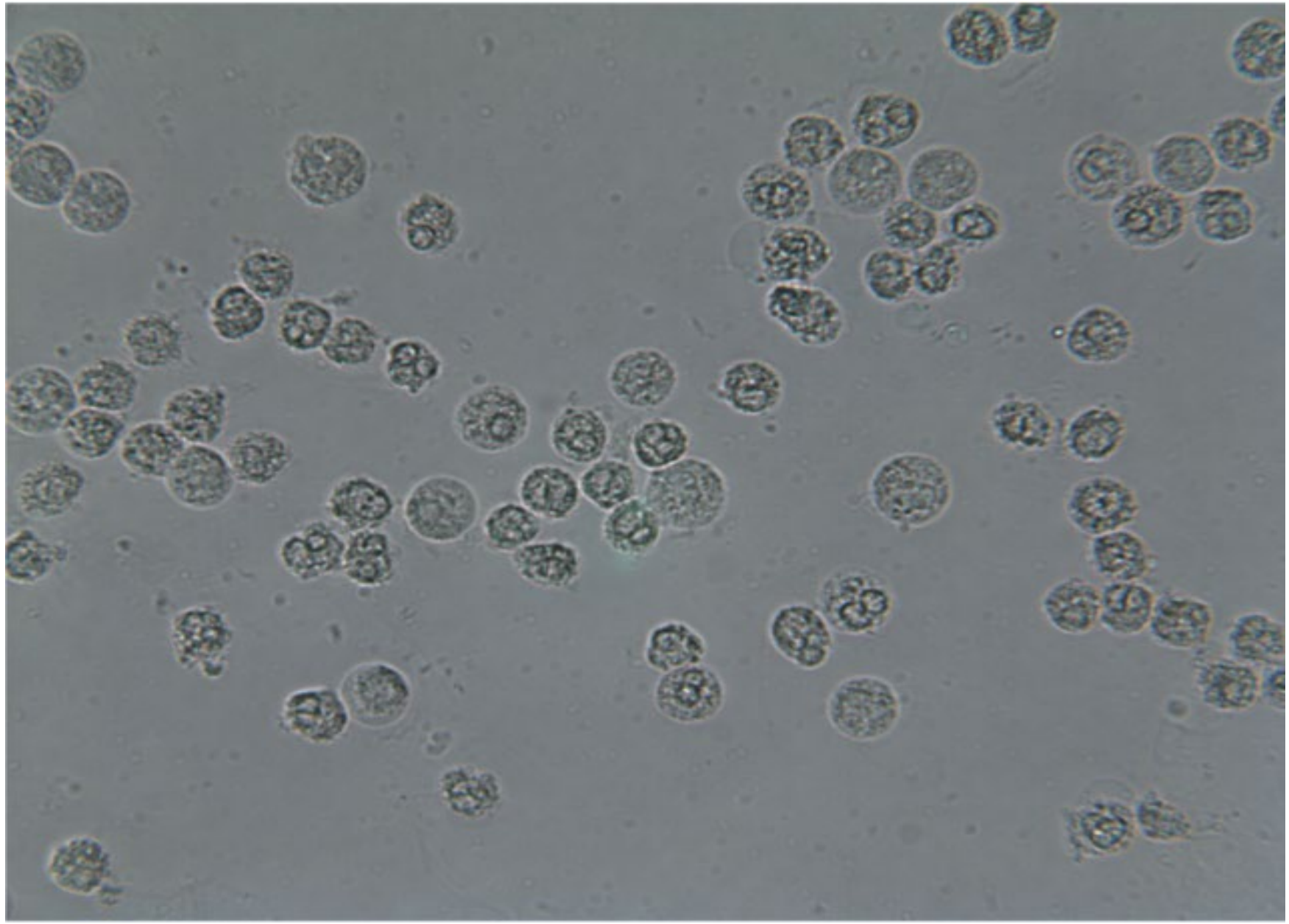


# WBC: leukocytes

- Cytoplasm
  contains granules
- Nucleus is
  segmented (lobed)
- Can be found singly or in clumps



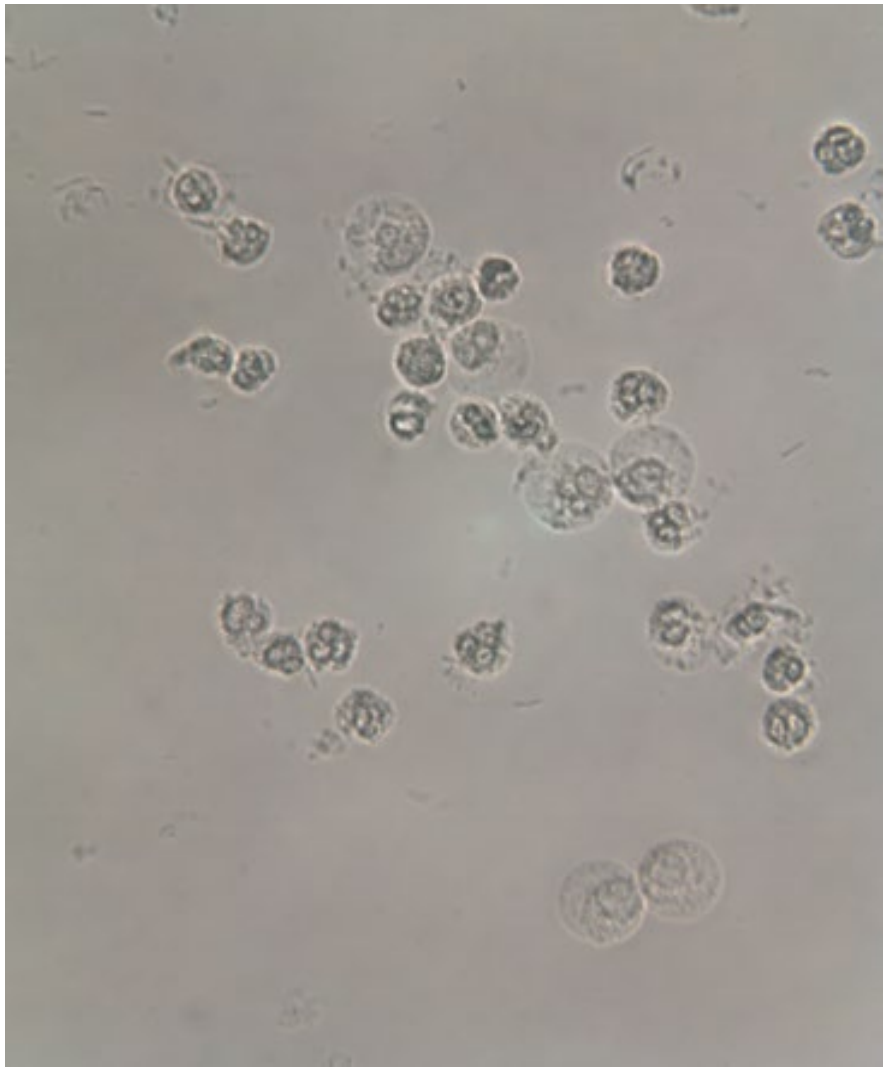

WBC clump



# Hypotonic (dilute) Urine

- Dilute urine: WBC swell and then lyse

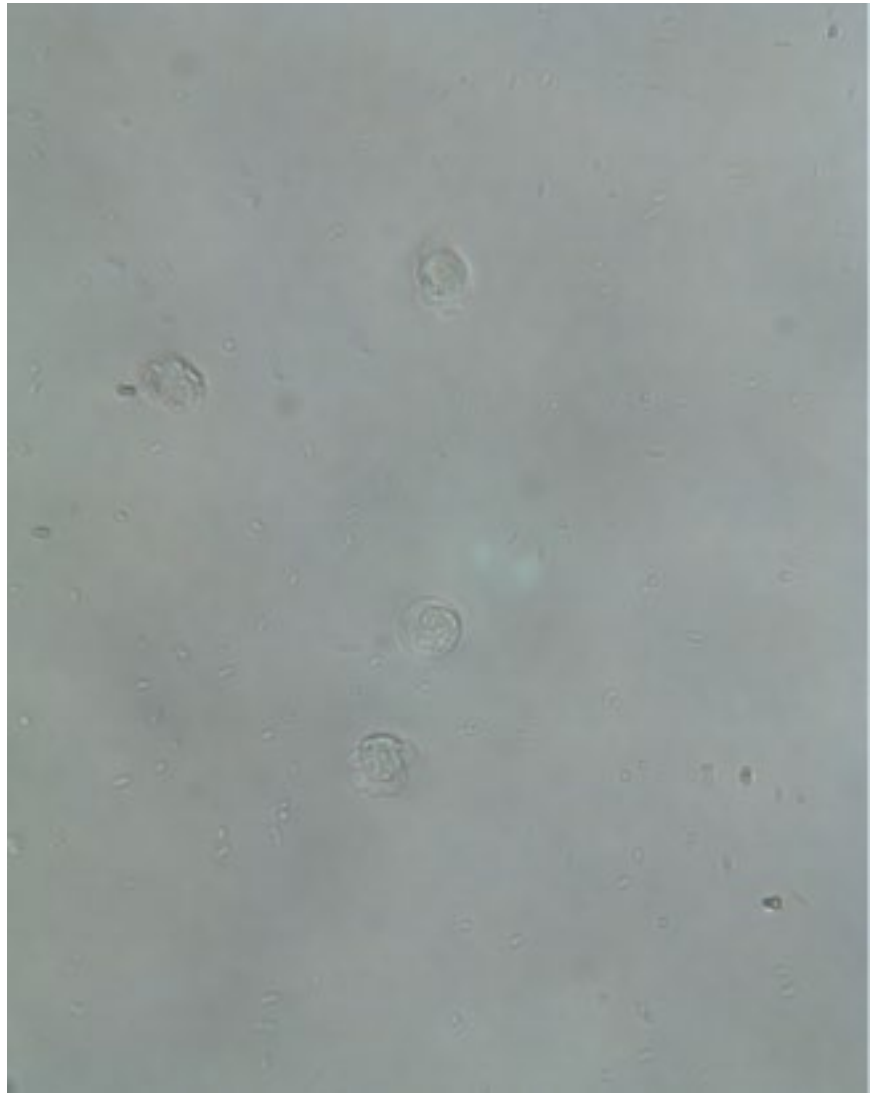
- Glitter cells: swollen WBCs showing brownian movement



# Hypertonic (concentrated) Urine

- WBC become smaller, due to water moving out of the WBC

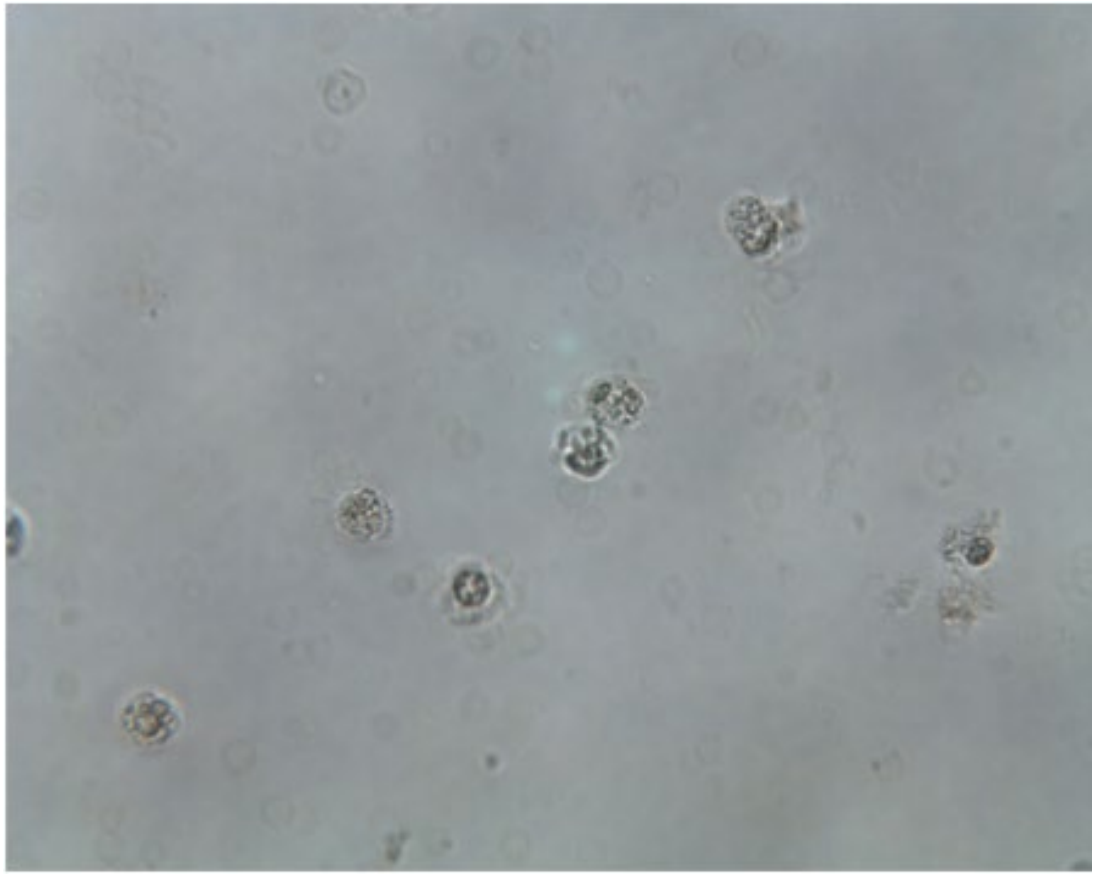
- Unlike RBC, WBC do not crenate



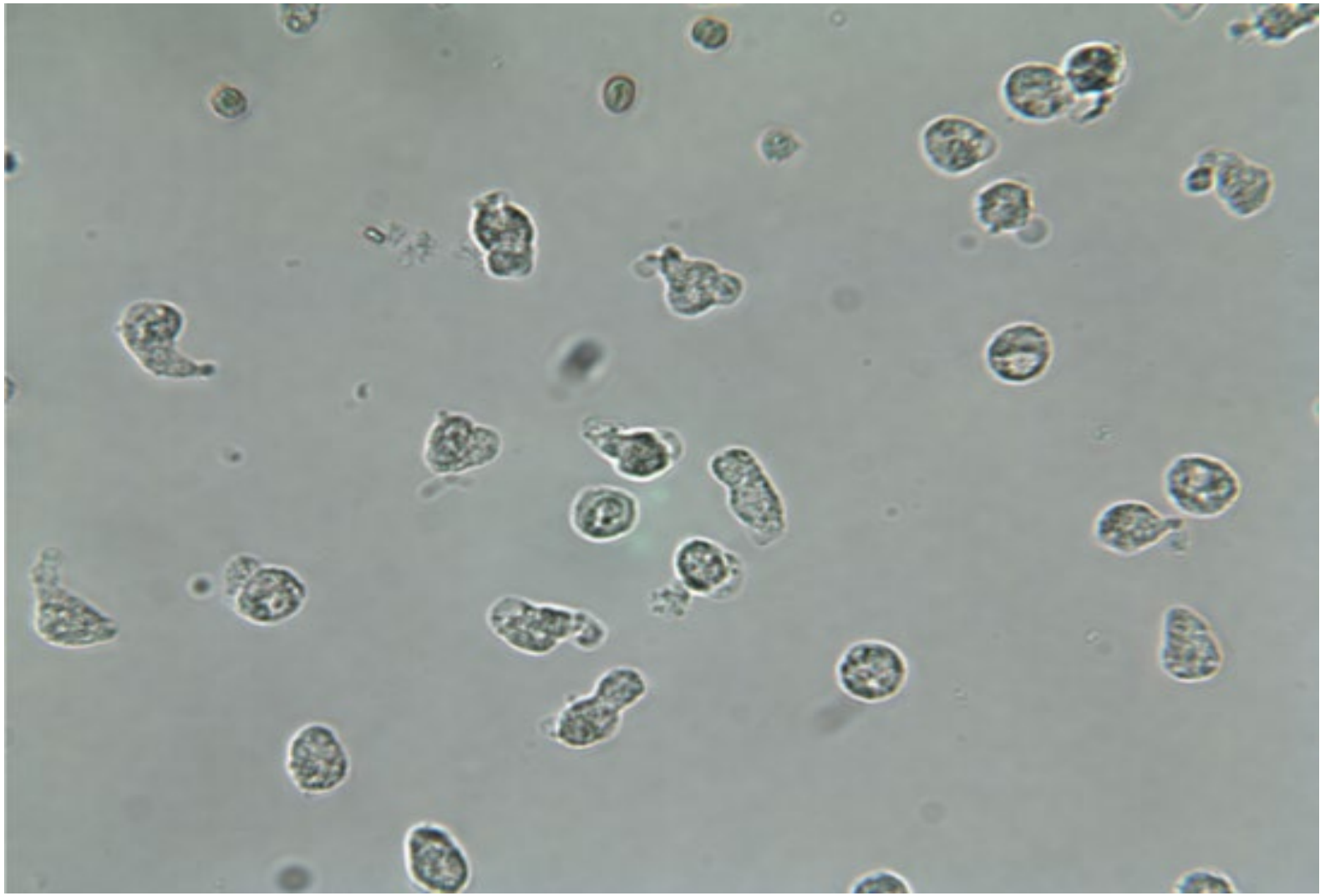
# Hypertonic (concentrated) Urine

- Use 2% acetic acid to differentiate WBC from crenated RBC

- RBC will lyse, WBC nuclear structure accentuated

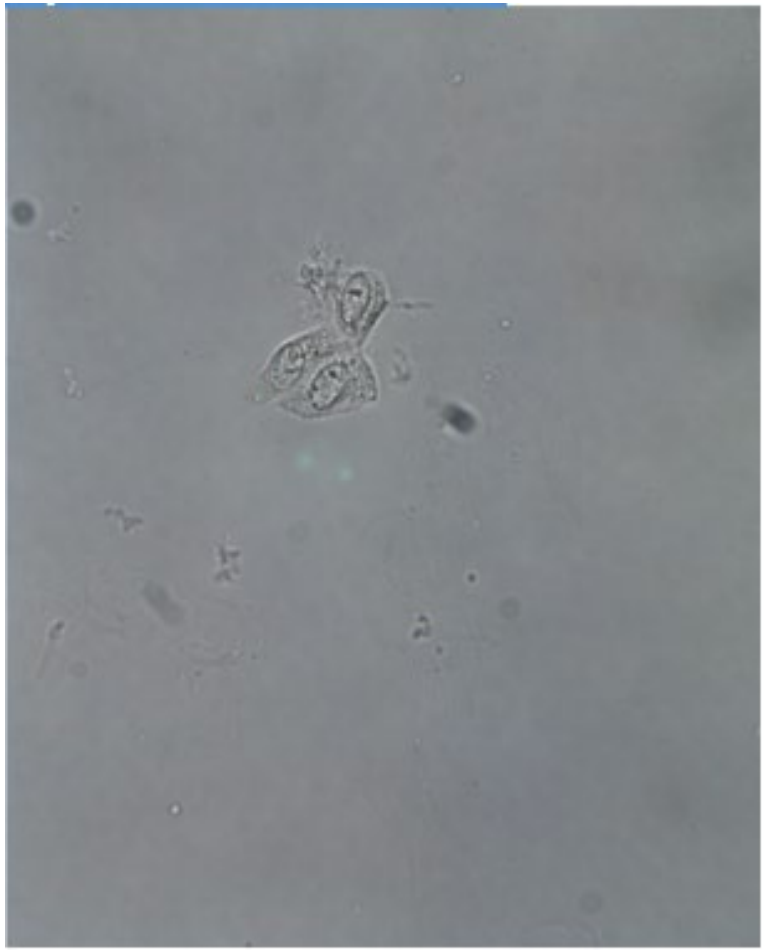


# WBC: degenerative changes

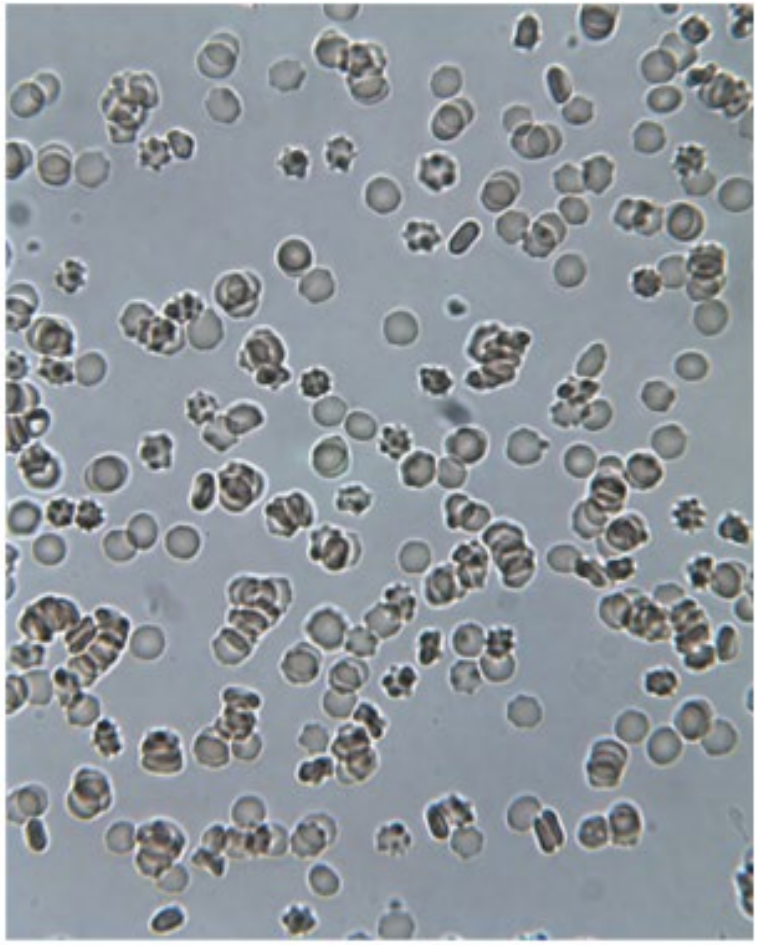


# WBCs can resemble:

**Renal tubular epithelial cells**



**Crenated RBC**



# WBC Correlation:

- **Correlate microscopic evaluation with :**
  - **Physical exam**
    - Color (infection)
    - Clarity
  - **Chemical exam**
    - Positive reagent strip for leukocyte esterase
    - Non-granular WBC (lymphocytes) will **not** react with reagent strip reaction (false negative)

# Epithelial Cells

- Found in urine due to
  - Normal sloughing of old cells from lining of genitourinary system
  - Inflammation of the lining
  - Renal disease

# Epithelial Cells

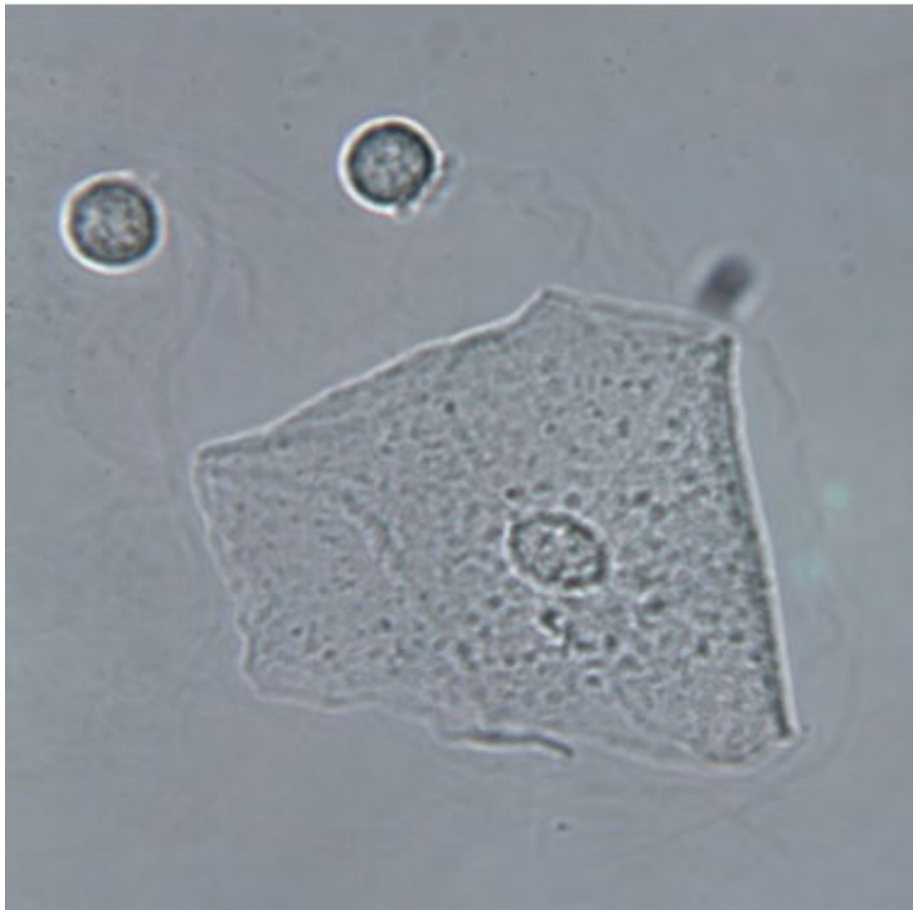
- Three types:
  - Squamous epithelial cells
  - Transitional epithelial cells
  - Renal tubular epithelial cells

- Normal: small amount

- Abnormal: infections, disease

# Squamous Epithelial Cells

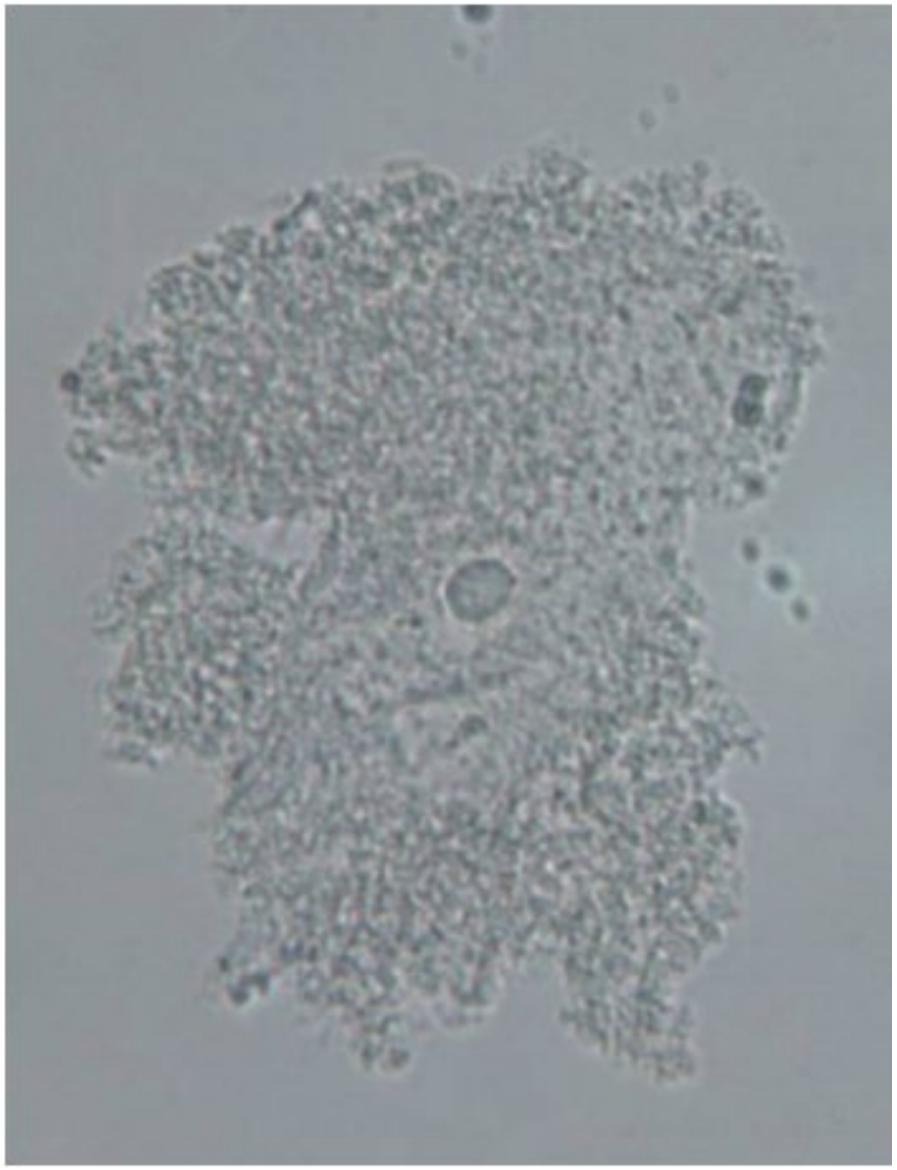
- Largest epithelial cell found in urine
- Enumerate using low power objective
- Cells are thin and flat; central nucleus
- Fine granulation in cytoplasm that becomes dense as cell degenerates



# Clue Cells

- Squamous epithelial cells with large amount of bacteria adhering to them giving them a ‘shaggy’ appearance

- Originates in vaginal mucosa; presence indicates bacterial vaginal infection



# Transitional Epithelial Cells

- Size varies dependent upon location in urinary tract
- Most common type seen in urine originates in the bladder
- Generally much larger than WBC with abundant cytoplasm; **nucleus to cytoplasm ratio ~ 1:5**
- Nucleus generally centrally located
- Borders of nucleus and cytoplasm distinct

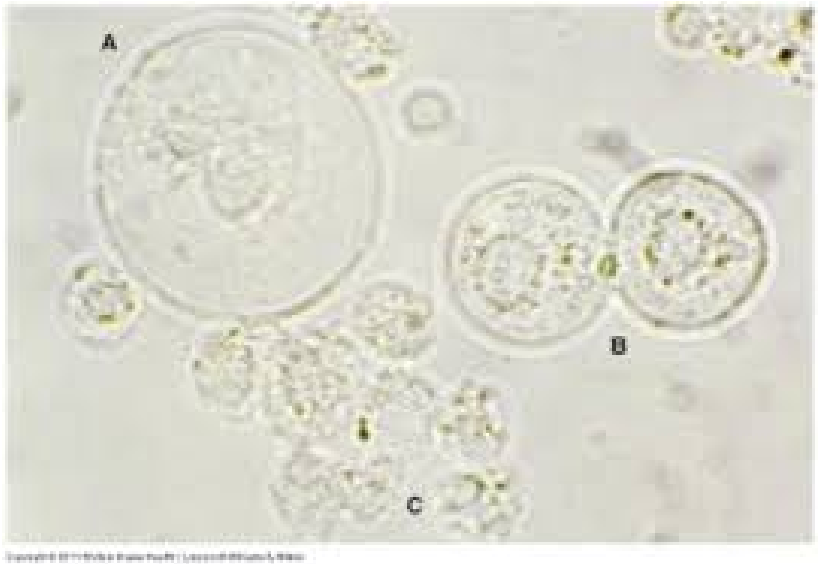
# Transitional Cells

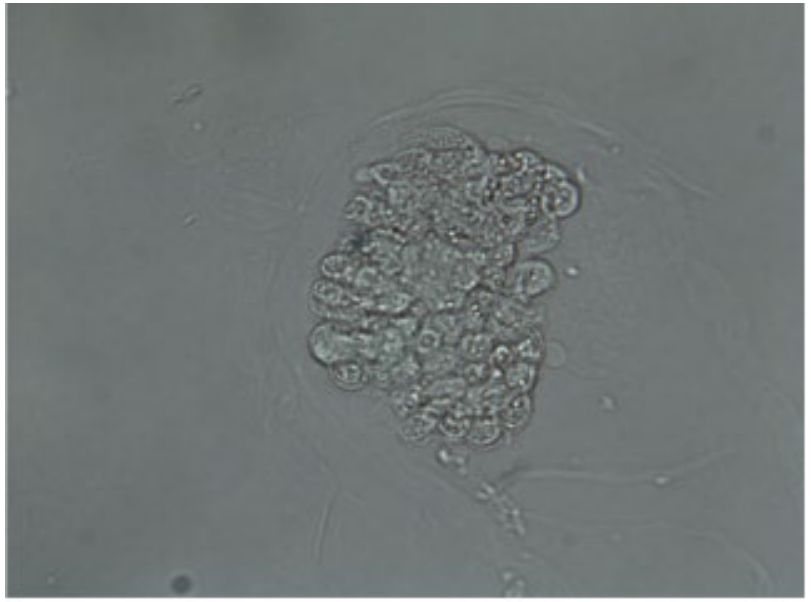
**Evaluate and enumerate using high power objective**

# Renal Tubular Epithelial (RTE) Cells

- Shape varies dependent upon location in urinary tract
- Cells usually are round and slightly larger than WBC
- Nucleus is eccentric; can be multinucleated
- Nucleus to cytoplasm ratio ~ 1:1

# RTE Cells



**Evaluate and enumerate using high power objective**

HK's Urinalysis

# Epithelial Cell Correlation:

- **Correlate microscopic evaluation with :**
  - **Physical exam**
    - Clarity
  - **Chemical exam**
    - Protein reagent strip reaction usually positive when RTE or oval fat body(OFB) present

# Casts

- Presence of casts reflect health status of renal tubules
- Normal: few hyaline or few granular casts
- Abnormal: increased number and type of cast significant

# Structural Make up of Casts

- Consists of a uromodulin matrix
- Uromodulin is a glycoprotein formerly called the Tamm-Horsfall protein
- This protein matrix does not react with the protein reagent strip test

# Cast Formation Enhanced By:

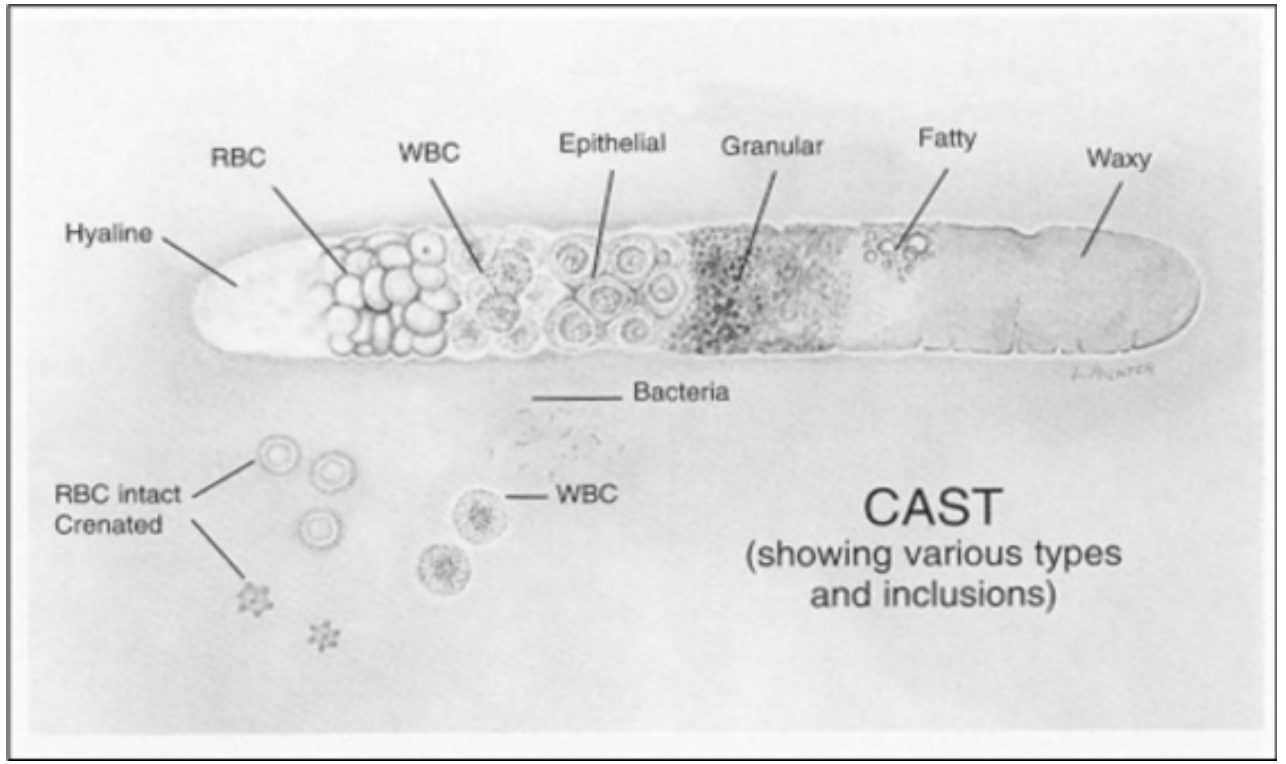
- Acidity of urine
- Increased solute concentration
- Decreased urine flow rate (urine stasis)
- Presence of plasma proteins (albumin, globulins, hemoglobin, myoglobin)

# Characteristics of Casts

- Cylindrical, cigar shape, parallel sides
- Vary in length and width
- Mucus and fibers can be misidentified as casts

# Cast Identification/Classification

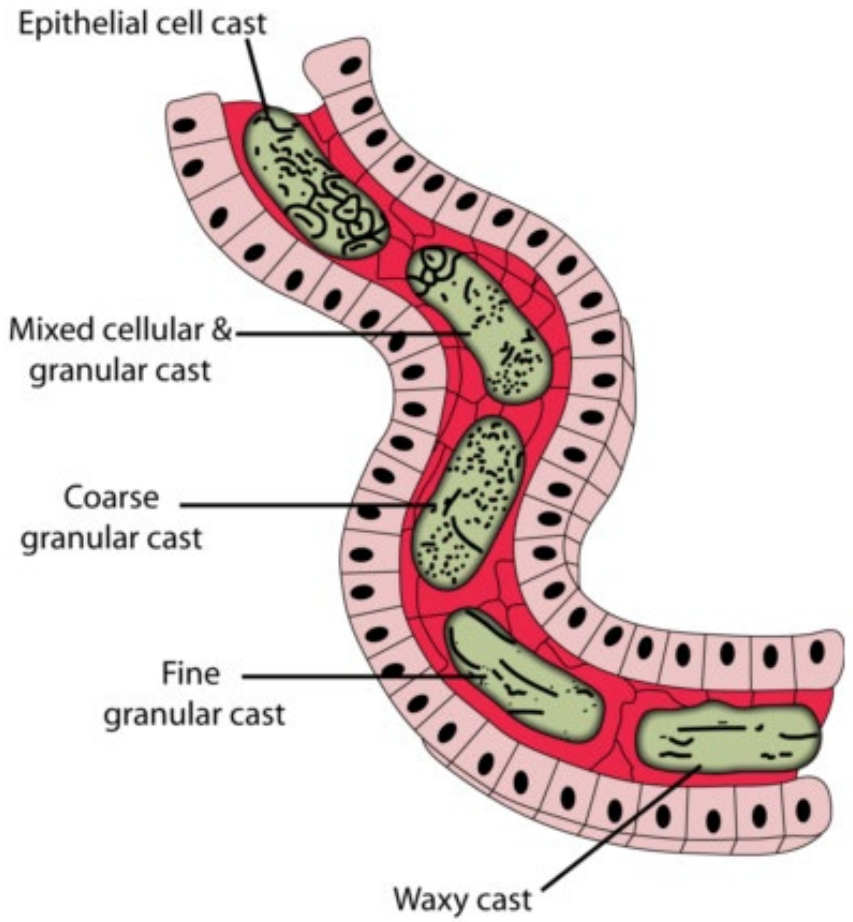
- Enumerate using low power objective;
- Identify using high power objective
- Classified by substance incorporated into cast matrix



# Cast Identification/Classification

- Youngest cast is the hyaline, oldest is waxy

- Cast becomes waxy as the cast ages and substances inside the cast degenerate

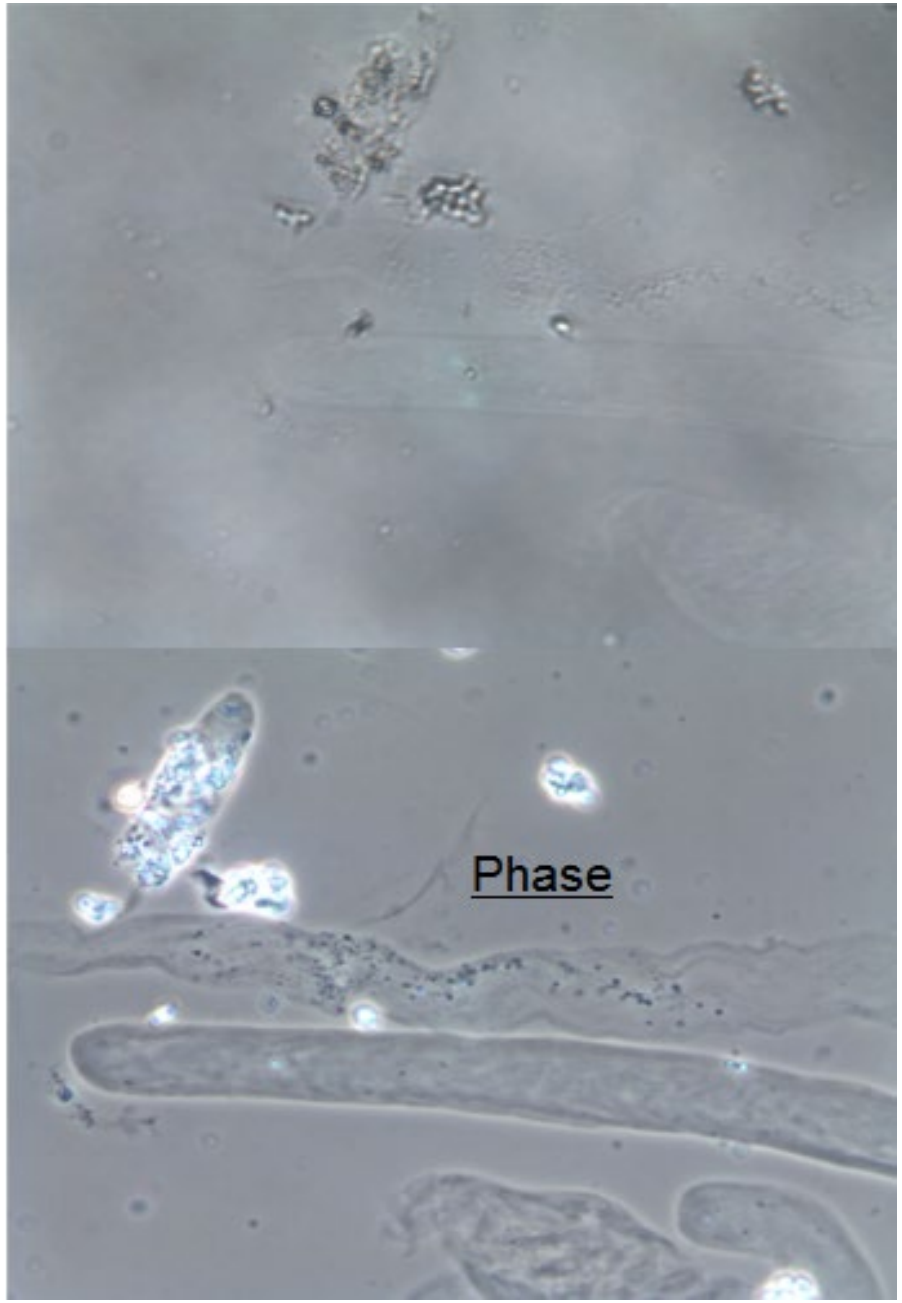


# Hyaline Cast

- Low refractive index and homogeneous matrix makes this cast very hard to see using bright field microscopy

  Adjust condenser to enhance visualization

- Phase microscopy used to enhance visualization

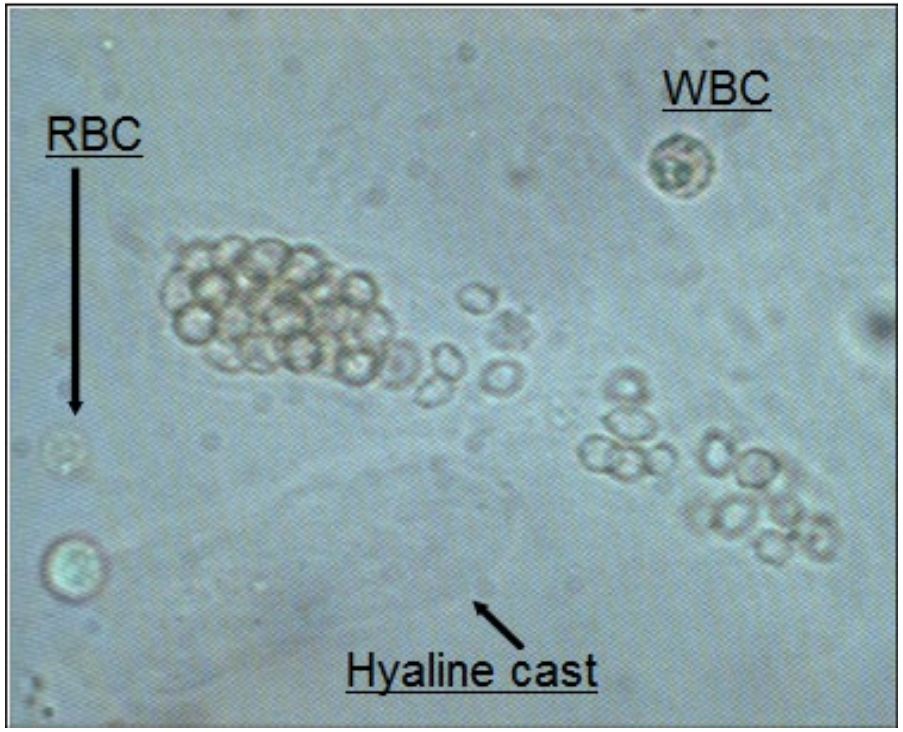


# Hyaline Cast

- Most common cast seen in normal individuals
- Normal: 0-2 hyaline casts/lpf
- Increased amounts seen with dehydration, fever, emotional stress, strenuous exercise

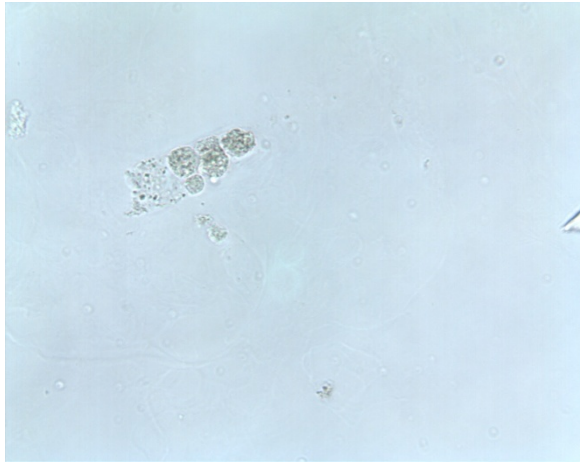
# RBC Cast

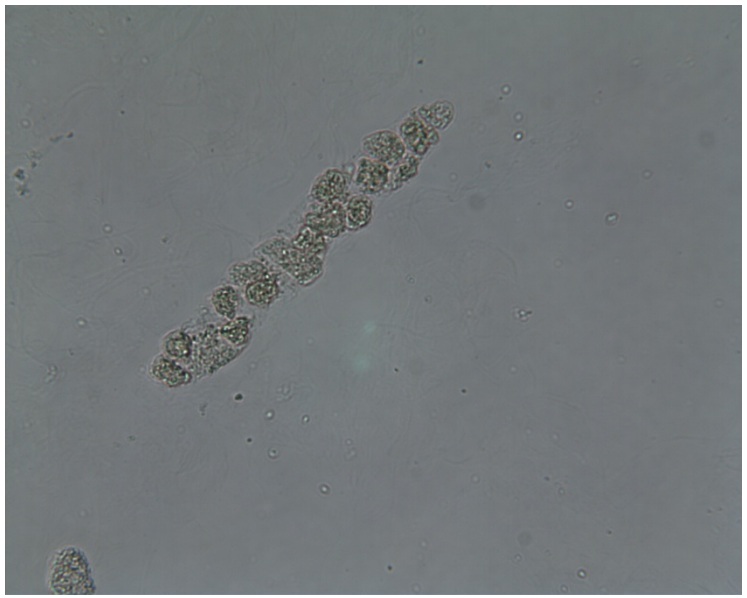
- RBC inside a hyaline cast
- Cast may appear yellow to reddish-brown color due to degenerating or hemolyzing RBCs
- Significance: pathologic condition (not normal)

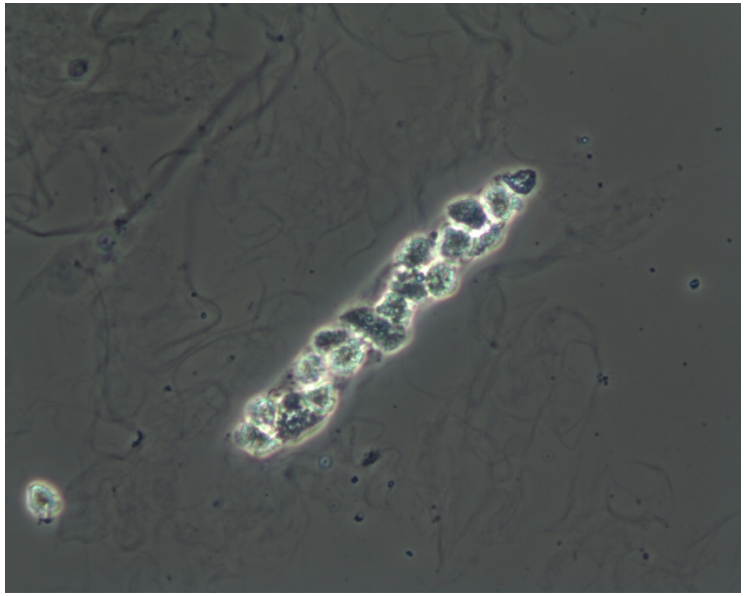


# WBC Cast

- WBC inside a hyaline cast
- Identify by looking for lobed nucleus
- Significance: pathologic condition (not normal)

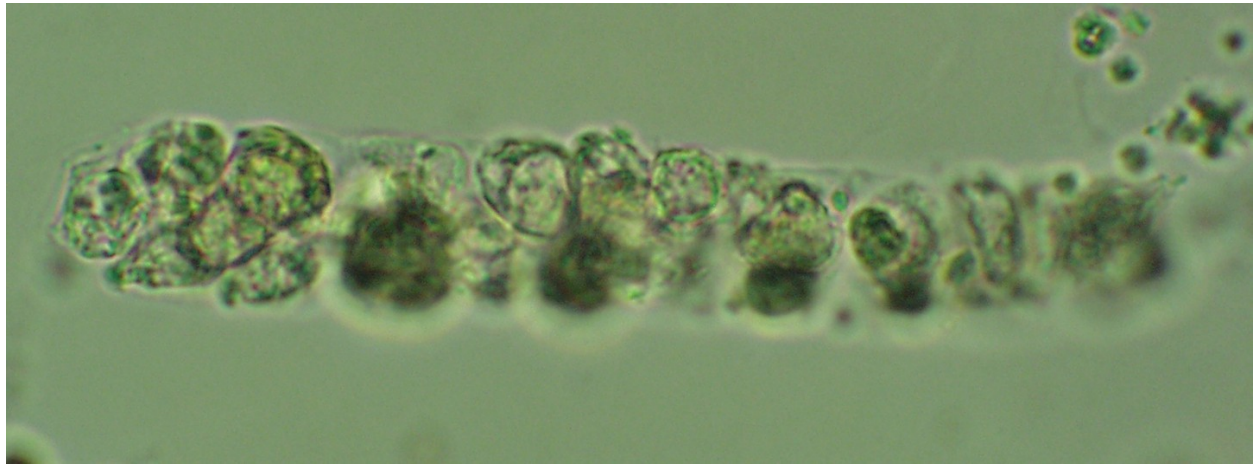






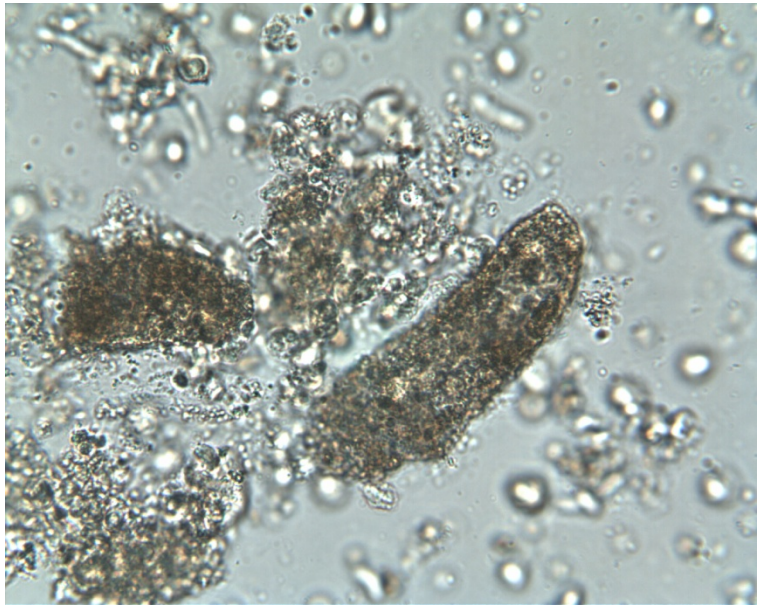
# Epithelial Cell Cast

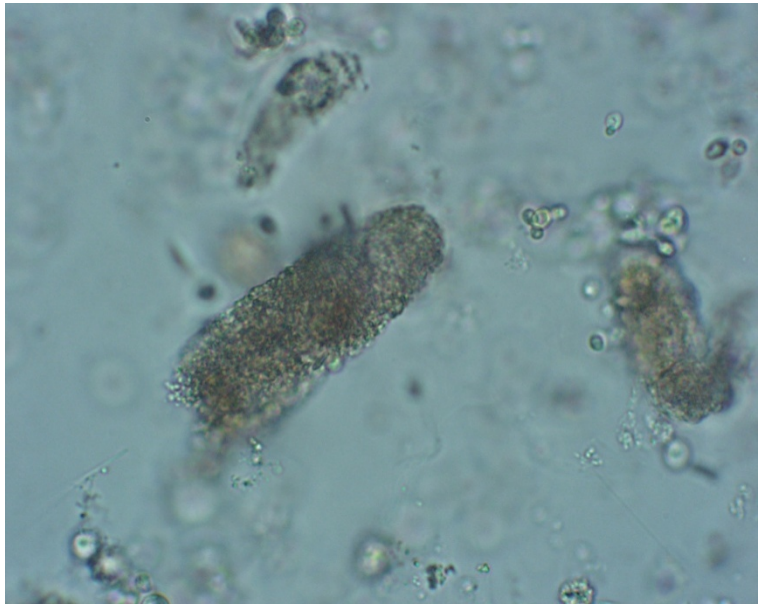
- Renal tubular epithelial cells in hyaline matrix
- Can be misidentified as WBC cast; look for 1:1 ratio of nucleus to cytoplasm
- Significance: always pathologic (never normal)



# Granular Cast

- Aged cellular cast: fine or coarse granules
- Significance: pathologic

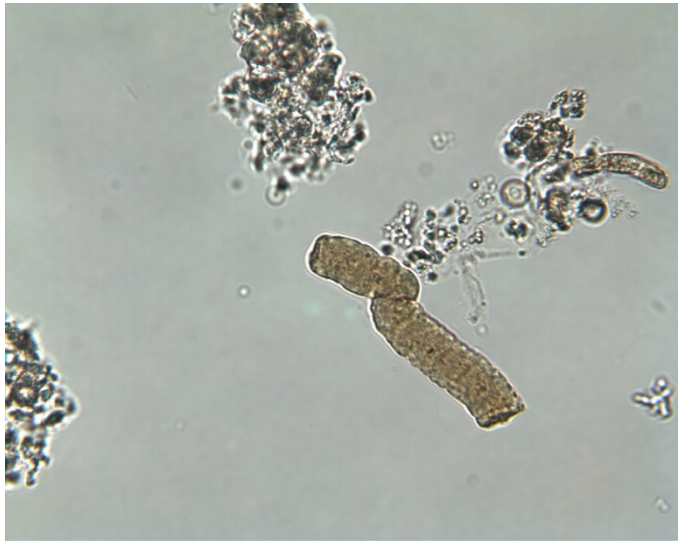


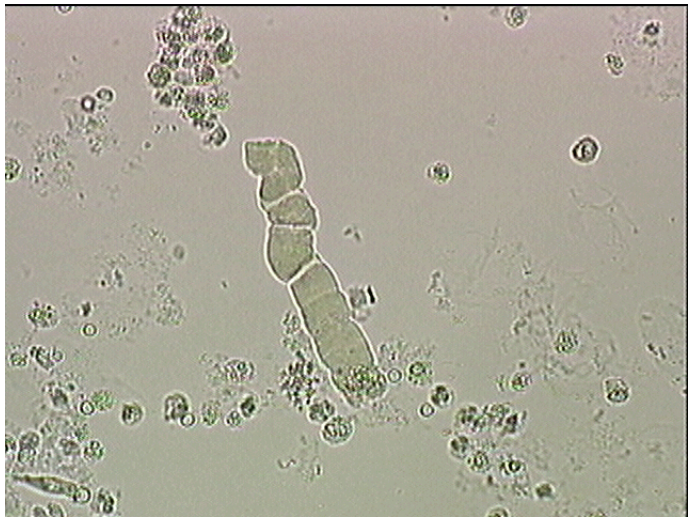


# Waxy Cast

- Highly refractile, homogeneous texture, well defined edges, blunt uneven ends
- May see cracks along the length of the cast
- May appear yellow to gray
- Significance: pathologic (prolonged stasis)

# Waxy Cast

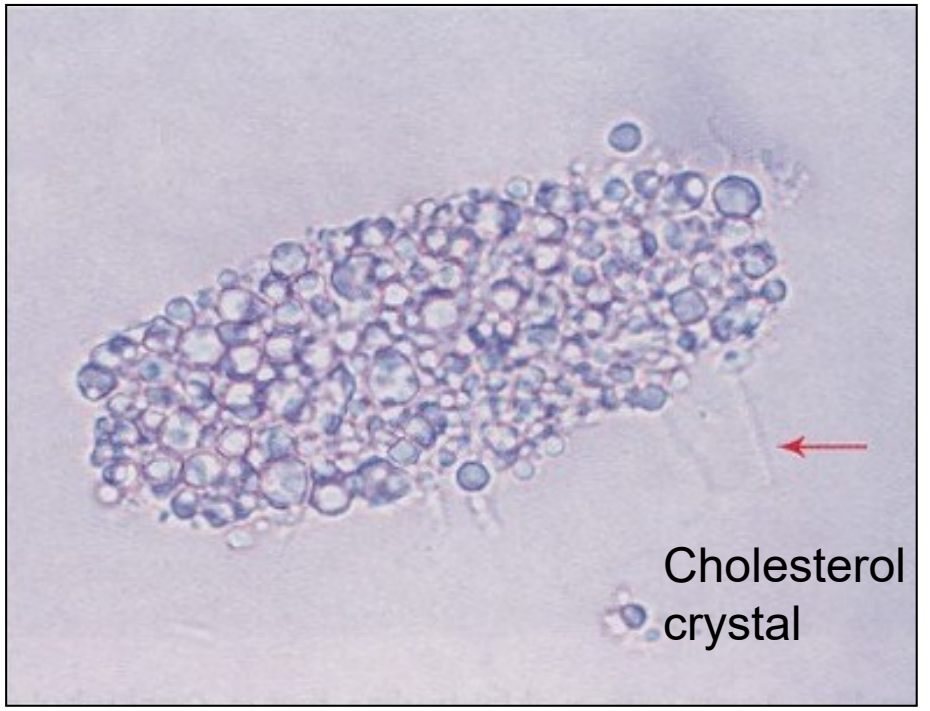


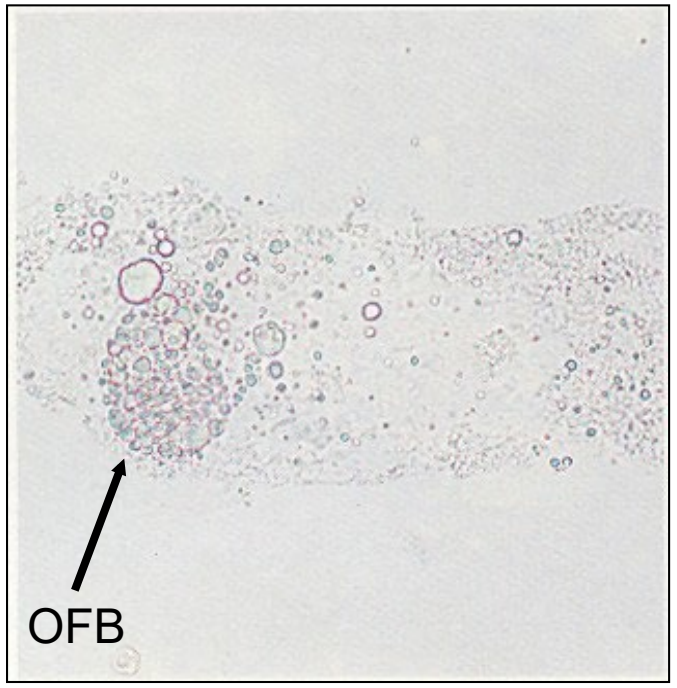


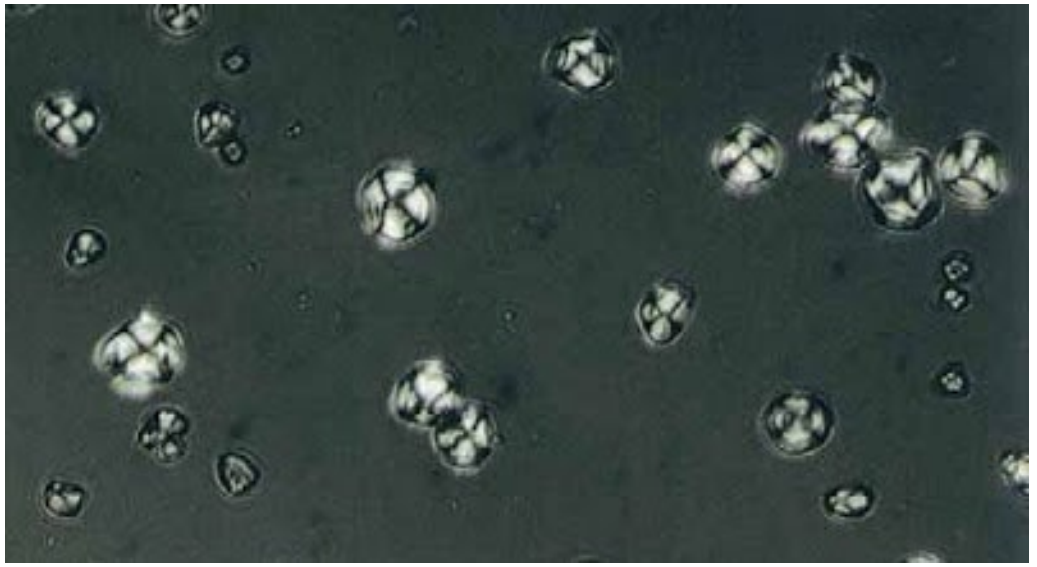
# Fatty Cast

- Highly refractile due to fat content
- Fat in the form of free fat droplets or oval fat bodies
- Identify using polarized microscopy: look for characteristic maltese cross formation
- Significance: pathologic finding, often seen in Nephrotic Syndrome

# Fatty Cast



"Maltese-cross" formation (polarized)

# Broad Cast

- Broad casts are wider than normally seen, since they are formed in the wider collecting ducts

- All types of casts may occur in this wider form

- Significance: pathologic

# Cast Correlation

- **Correlate microscopic evaluation with**
  - **Physical exam**
    - Clarity
  - **Chemical exam**
    - Not react with the protein reagent strip test

# Crystals

- Not normally found in fresh urine
- If found in fresh urine, pathologic
- Crystals precipitate as urine cools to room temp or when urine is refrigerated
- All clinically significant crystals are found in acid urine

# Crystal Formation Enhanced By

- Increased concentration of solute in urine
- Urine pH
- Urine stasis
- Temperature

# Crystal Identification

- Microscopic appearance
- Urine pH

# Crystal Correlation

- **Correlate microscopic evaluation with**
  - **Physical exam**
    - Color
    - Clarity
  - **Chemical exam**
    - pH

# Crystals

- Normal acid pH crystals
- Normal alkaline pH crystals
- Pathologic crystals found in acid or neutral urine
- Drug induced crystals

# Normal Acid pH Crystals

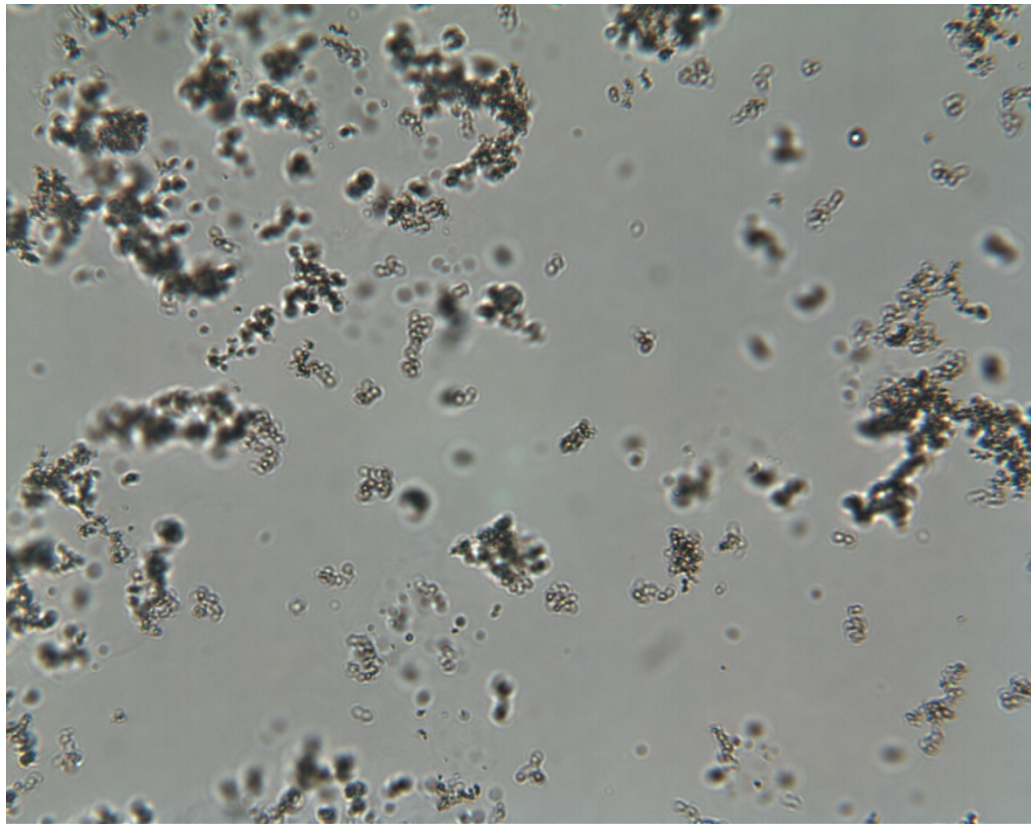
- Amorphous urates
- Uric acid
- Calcium oxalate

# Amorphous Urates

- These crystals have no distinct form and appear as sand-like granules microscopically

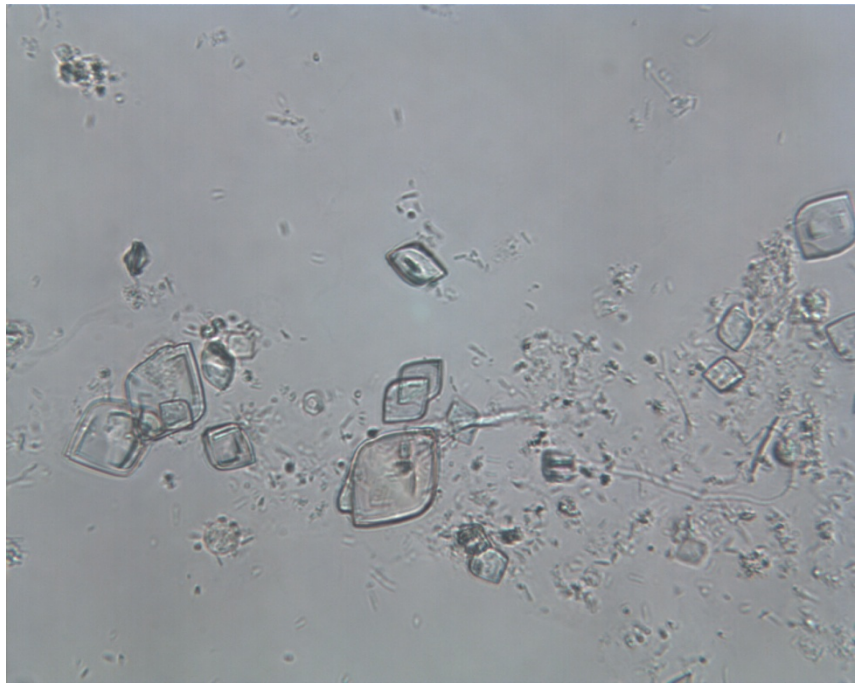
- Macroscopically appear as a pink sediment after urine centrifugation

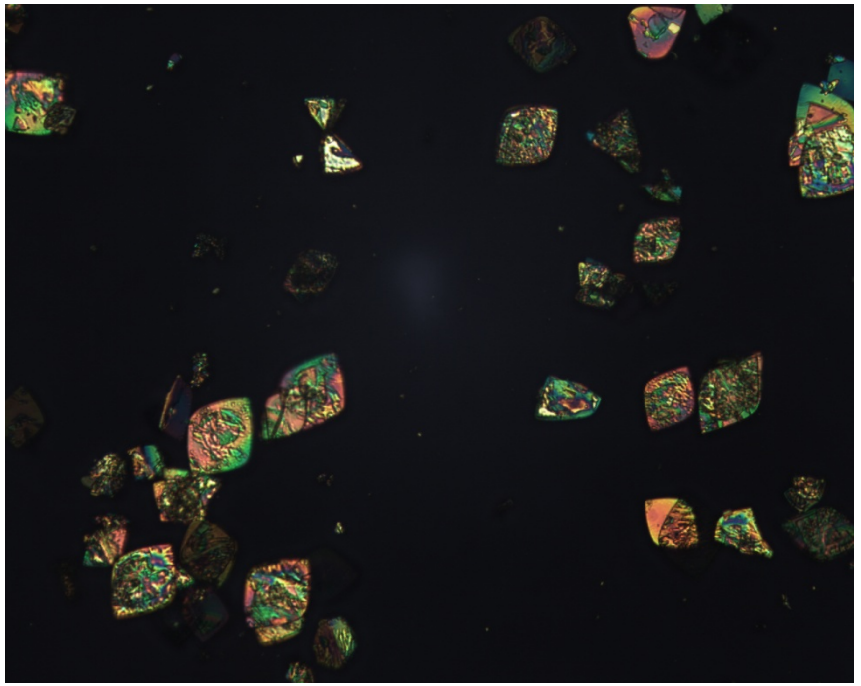
- Acid pH urine



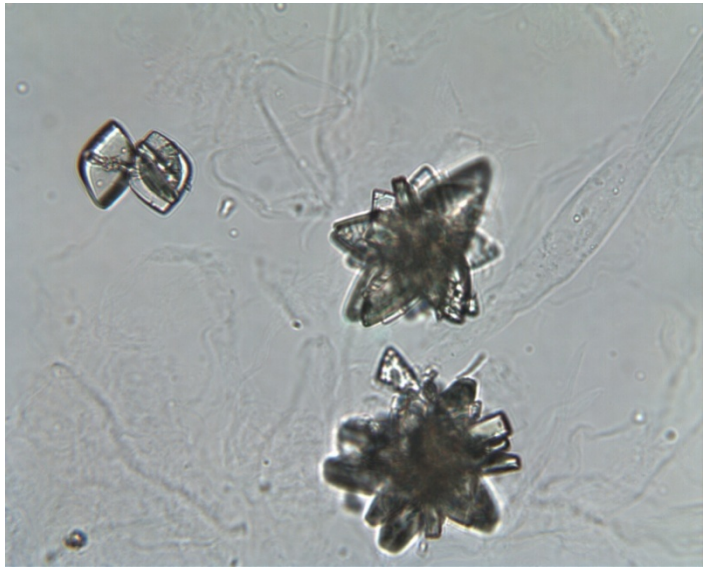
# Uric Acid Crystals

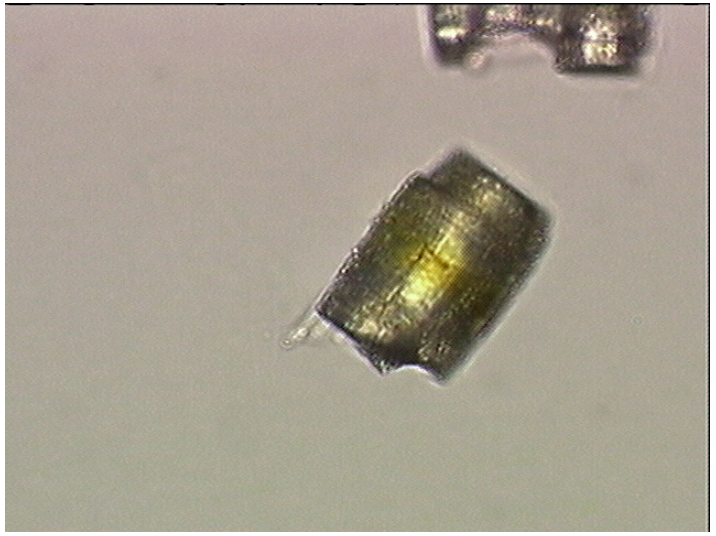
- Acid pH urine
- Appear in several forms
- Multicolored when polarized
- Diamond shape most common form

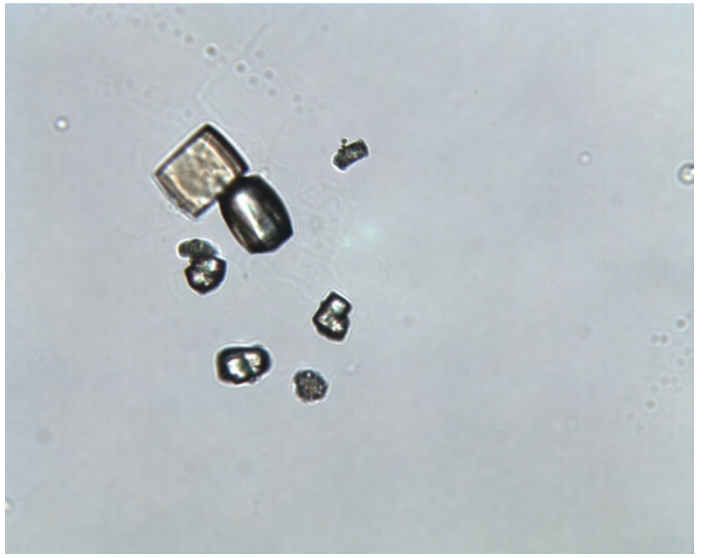




# Uric Acid Crystals



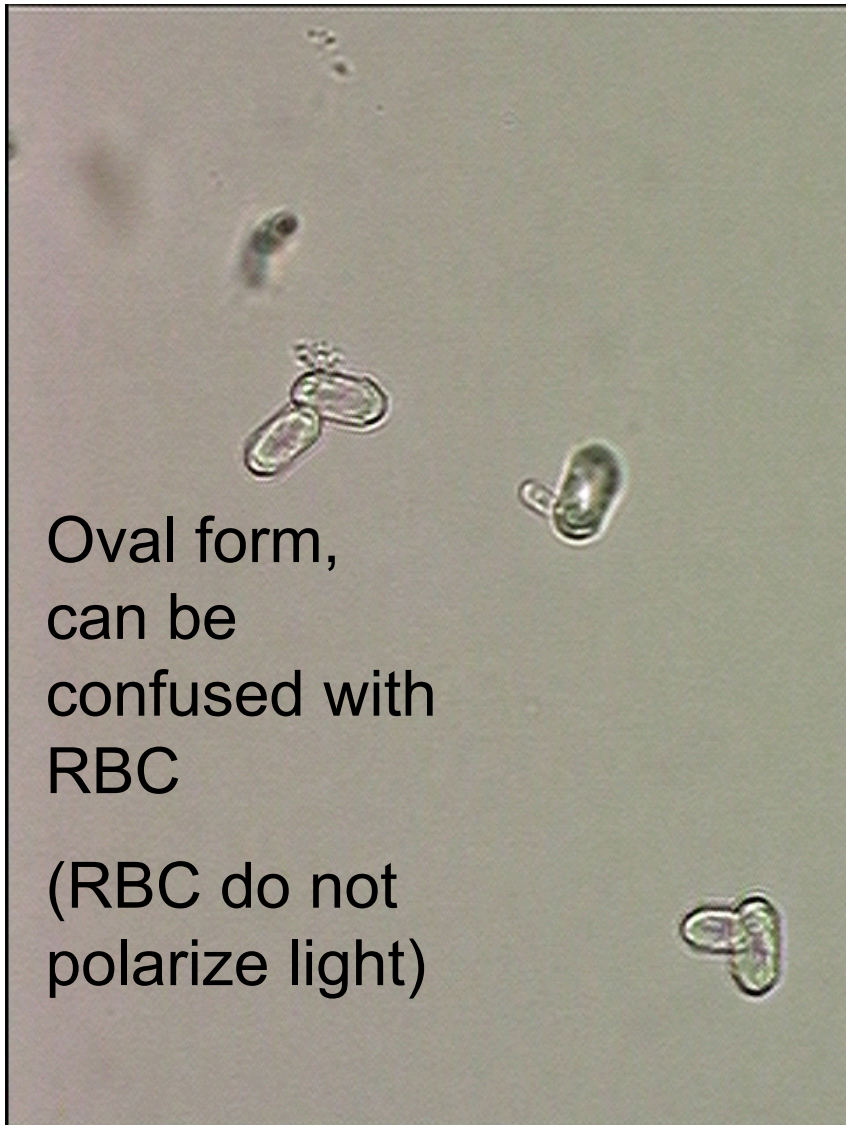




# Calcium Oxalate Crystals

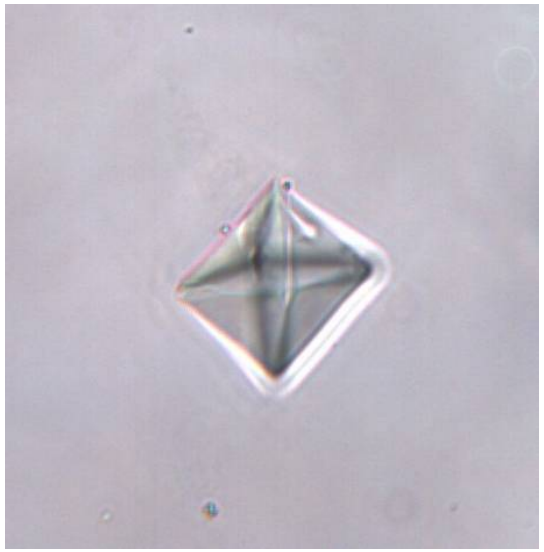
- Acid pH urine
- Most frequently observed crystal in urine
- Most common form is octahedryl shape, often referred to as an ‘envelope’ shape
- Multicolored when polarized

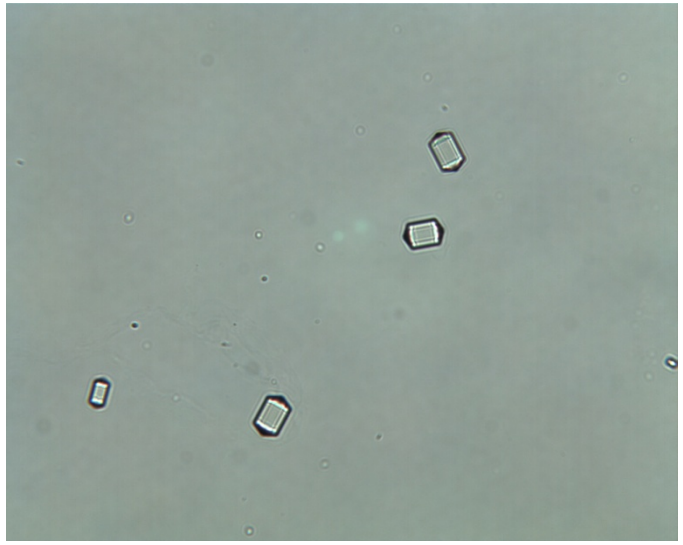
# Calcium Oxalate Crystals



Oval form, can be confused with RBC

(RBC do not polarize light)





# Normal Alkaline pH Crystals

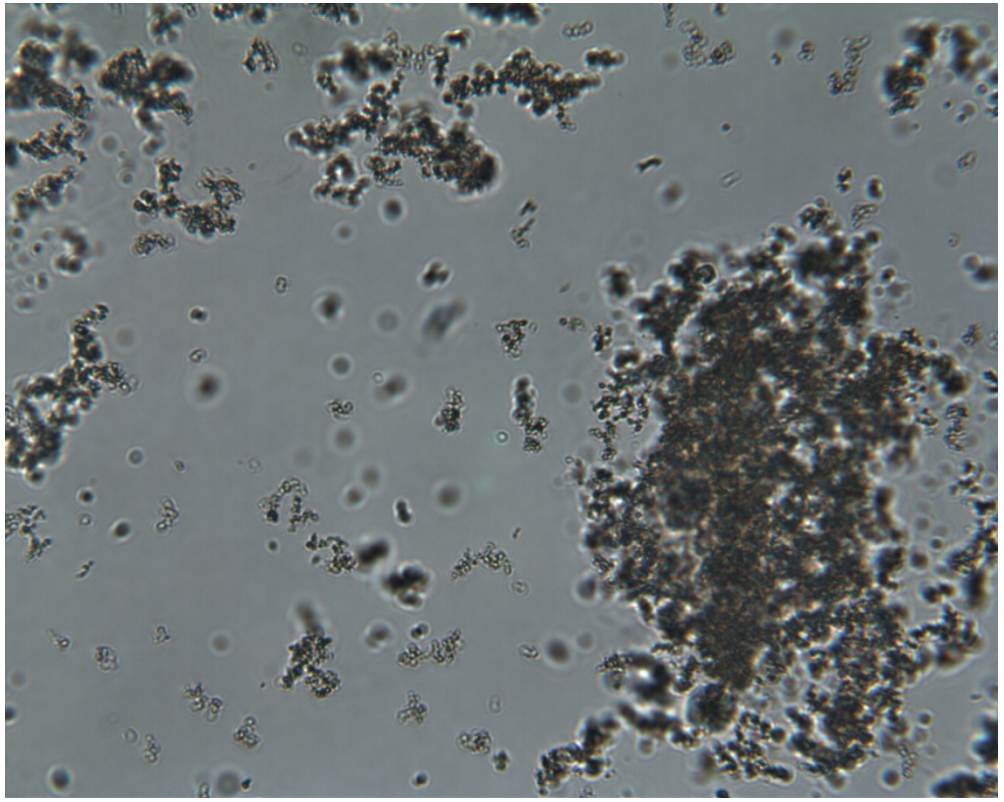
- Amorphous phosphates
- Triple phosphate
- Ammonium biurate
- Calcium carbonate

# Amorphous Phosphates

- These crystals have no distinct form and appear as sand-like granules microscopically

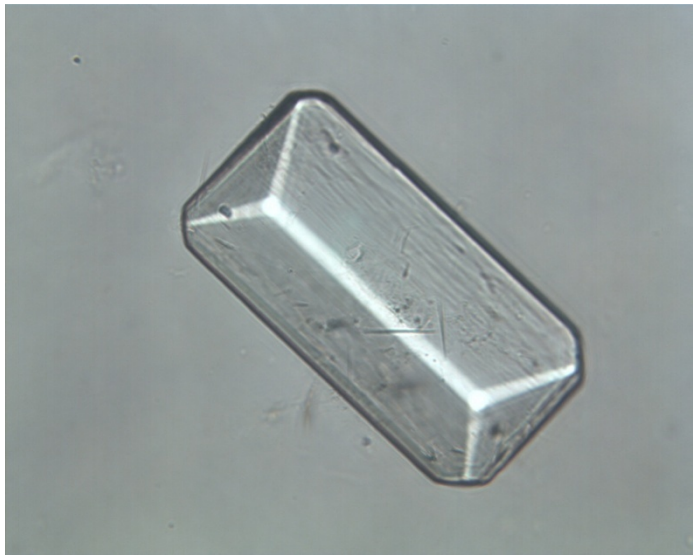
- Macroscopically appear as a white sediment after urine centrifugation

- Alkaline pH urine

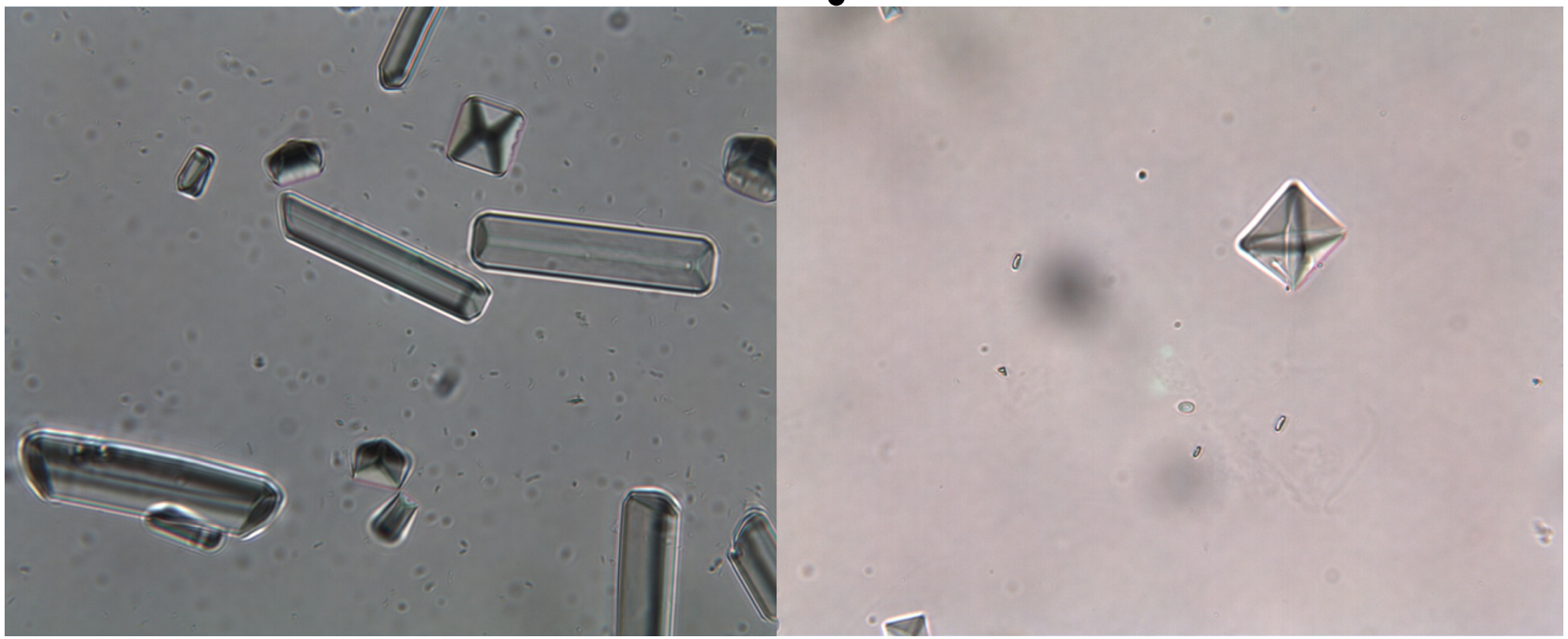


# Triple Phosphate Crystals

- Most frequently observed crystal in alkaline urine
- Colorless, 4-6 sided prisms
- Referred to as ‘coffin lid crystals’



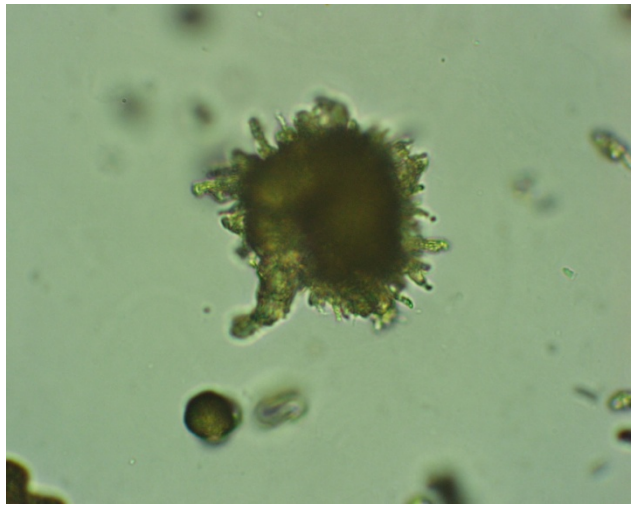
# Triple Phosphate vs Calcium Oxalate



Alkaline pH urine

Acid pH urine

# Ammonium Biurate Crystals

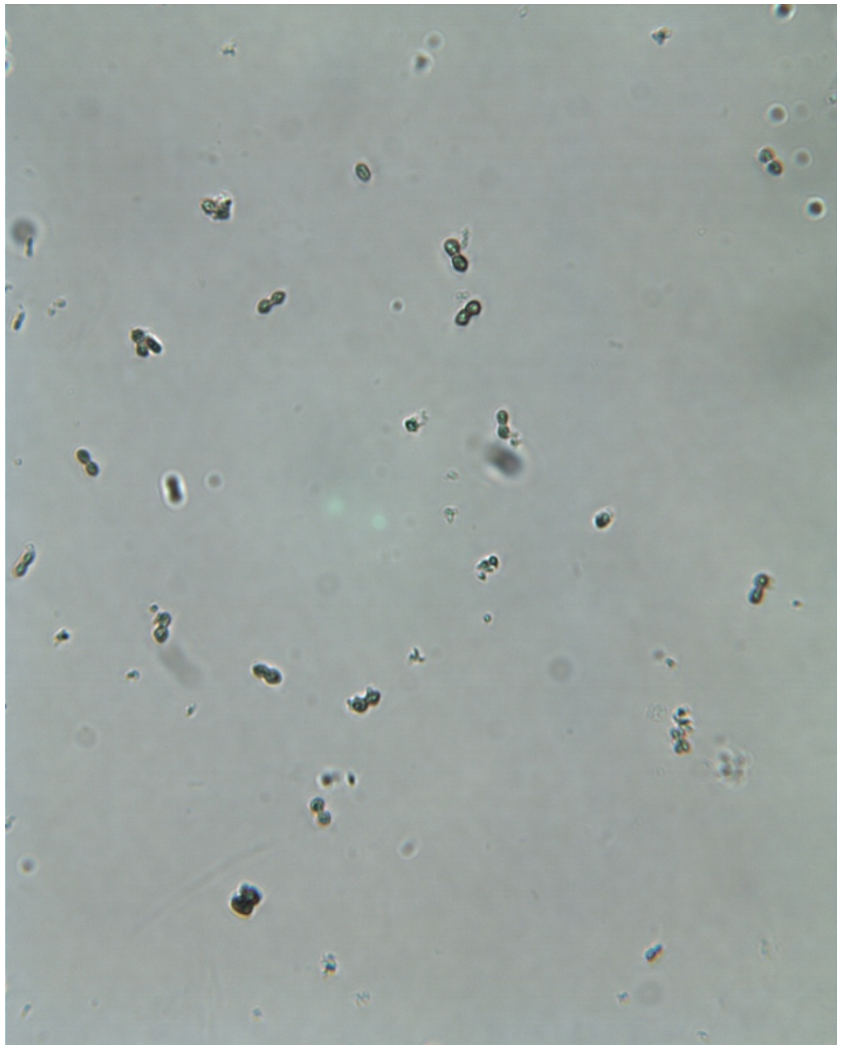


- Alkaline pH urine
- Yellow spheres with spicules on surface
- Referred to as ‘thorny apple crystals’

- Significant when found in fresh urine
- Presence indicates urine is old

# Calcium Carbonate Crystals

- Alkaline pH urine; very small colorless granules, slightly larger than amorphous material
- Multicolored when polarized
- Easily confused with bacteria

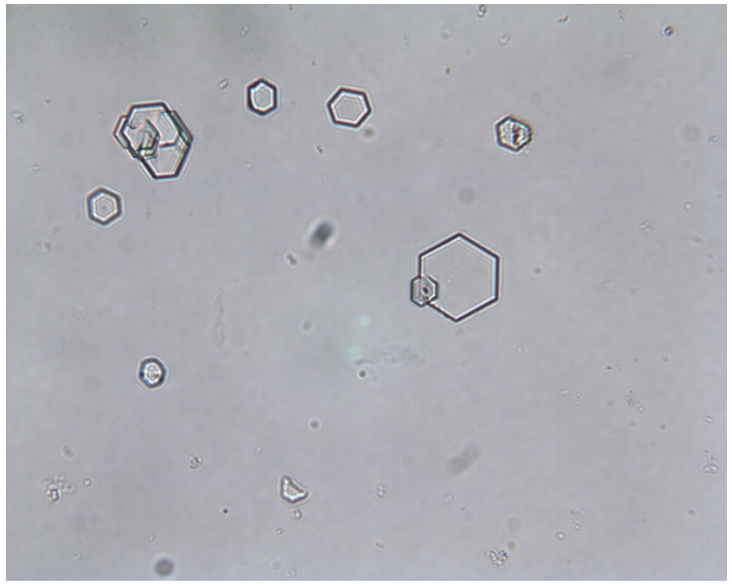


# Pathologic Crystals (acid, neutral pH)

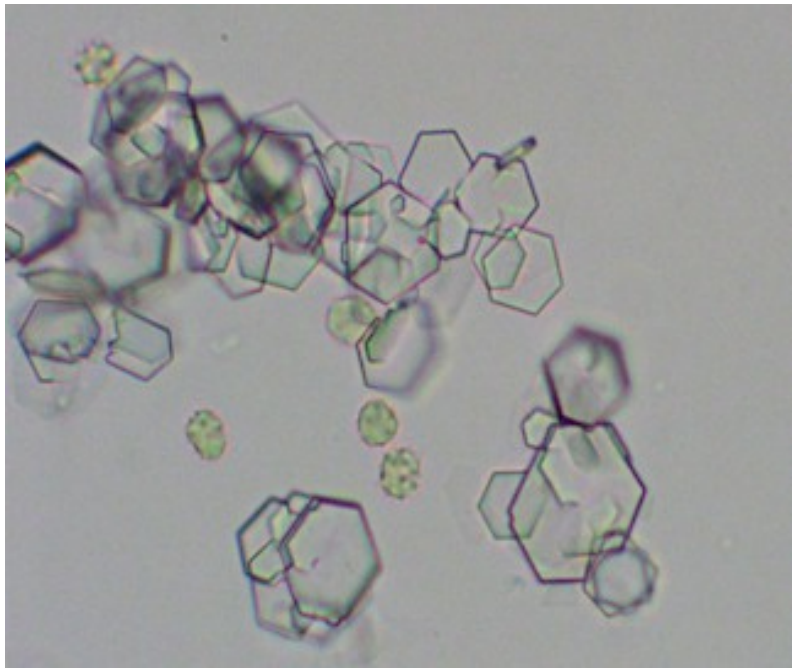
- Cystine
- Tyrosine
- Leucine
- Cholesterol
- Bilirubin

# Cystine Crystals

- Colorless hexagonal plates
- Do not polarize
- Can be confused with uric acid crystals



# Cystine vs Uric Acid Crystals



**Cystine Crystal**

**Acid pH urine**

**Do not polarize light**

**Uric Acid Crystal**

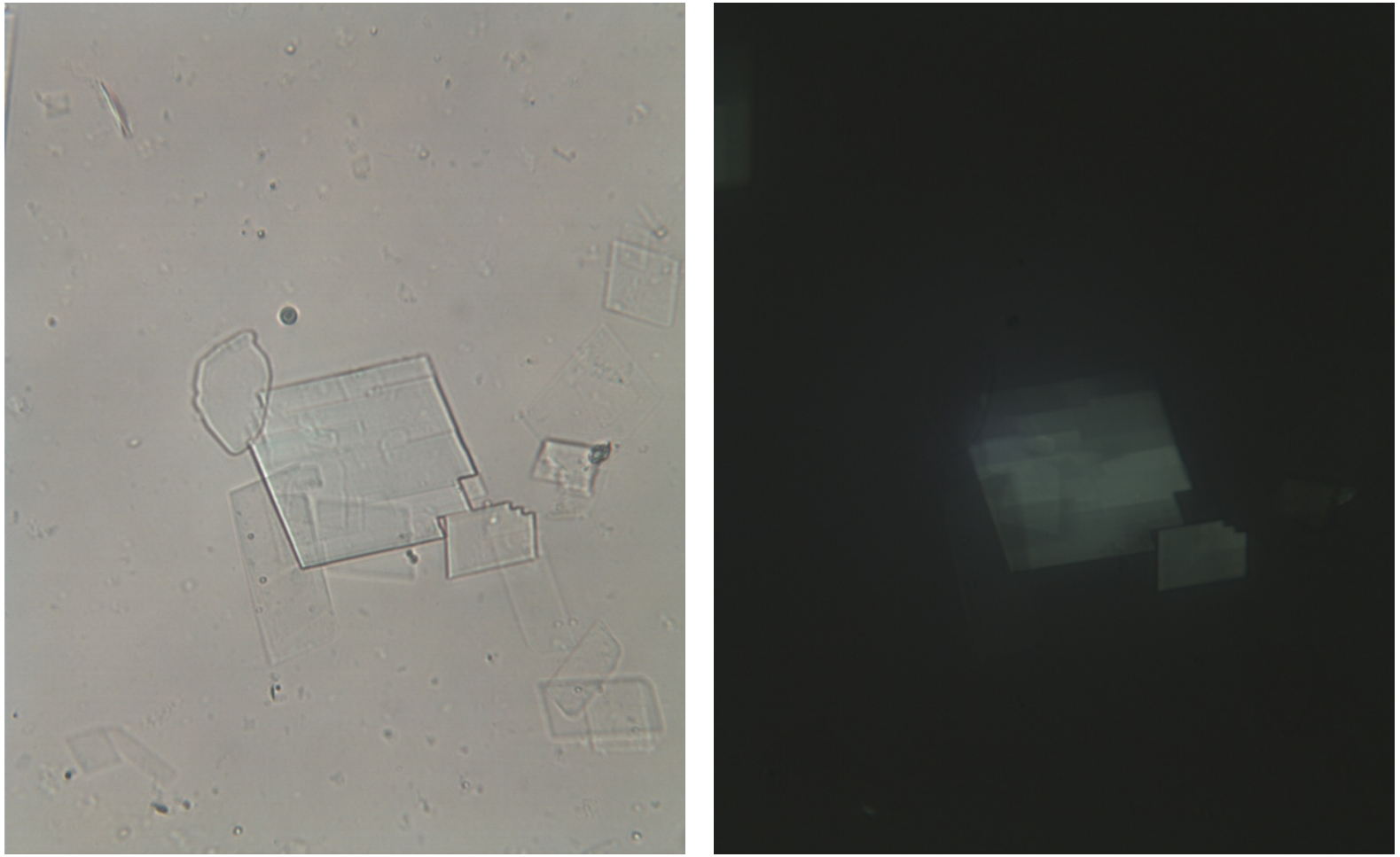
**Acid pH urine**

**Multicolored when polarized**

# Cholesterol Crystals

- Clear, large, flat, rectangular plates with notched corners
- Multicolored when polarized
- Can be confused with radiographic dye crystals

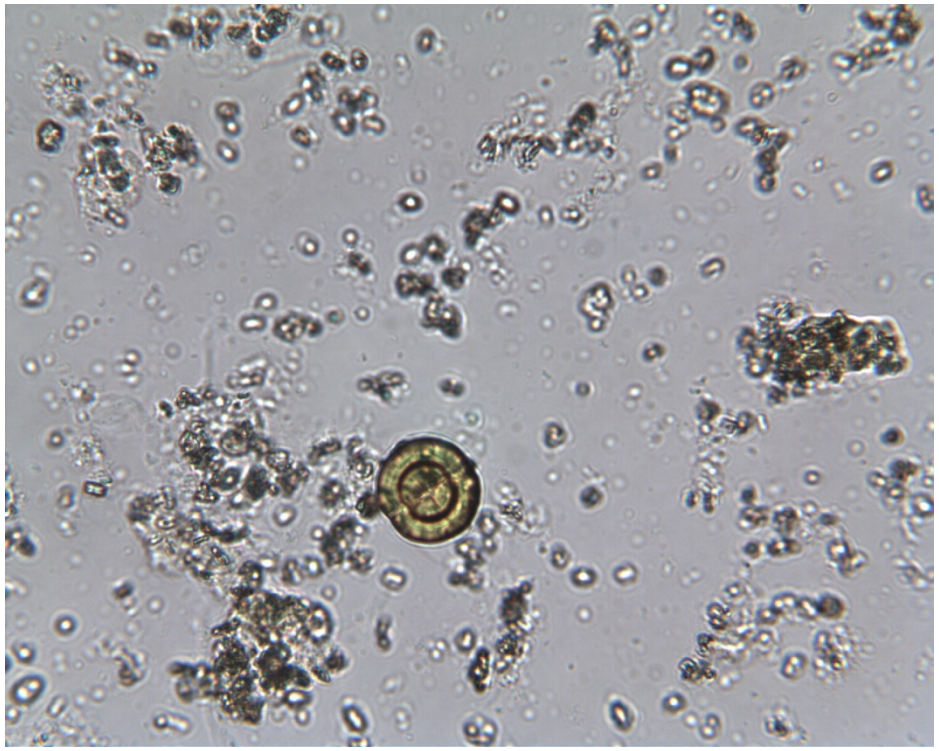
# Cholesterol Crystals



Bright field Light vs Polarized Light

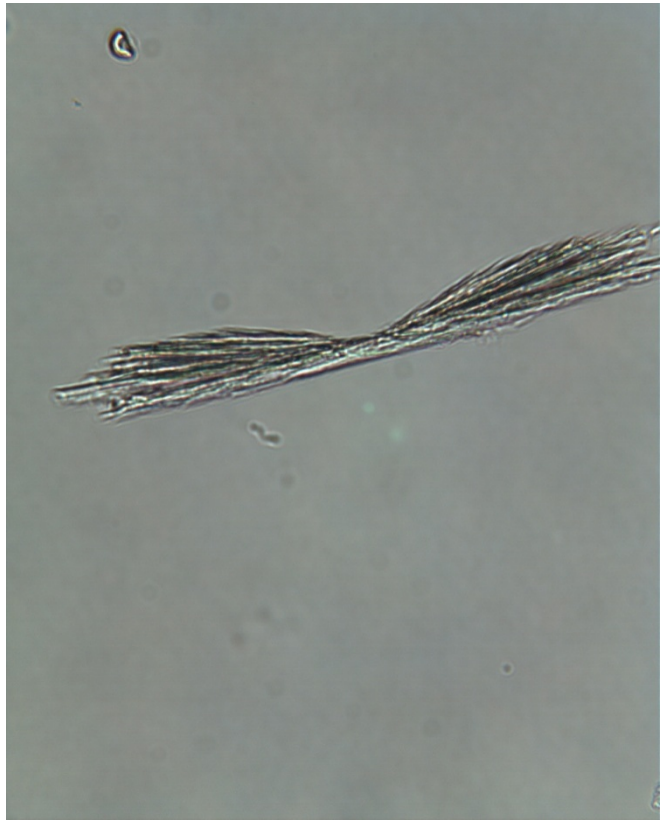
# Leucine Crystals

- Yellow-brown spheres with concentric circles on surface
- Can resemble free fat globules



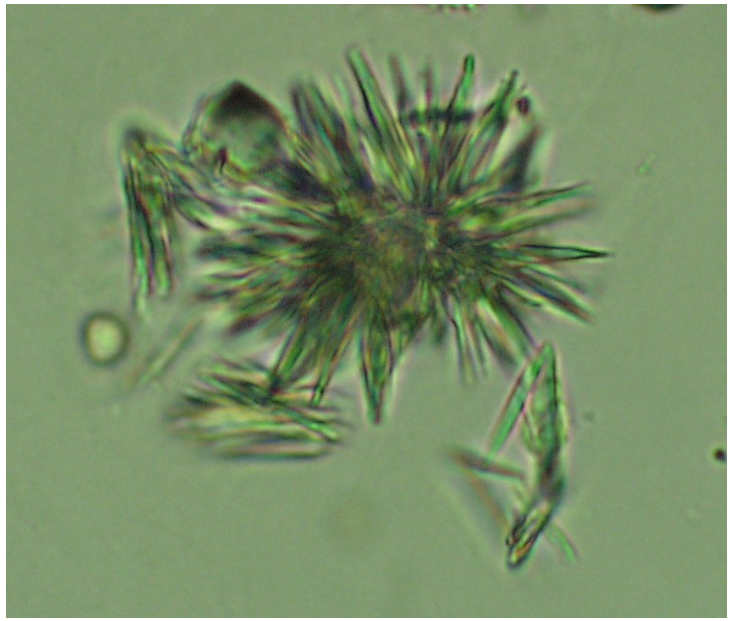
# Tyrosine Crystals

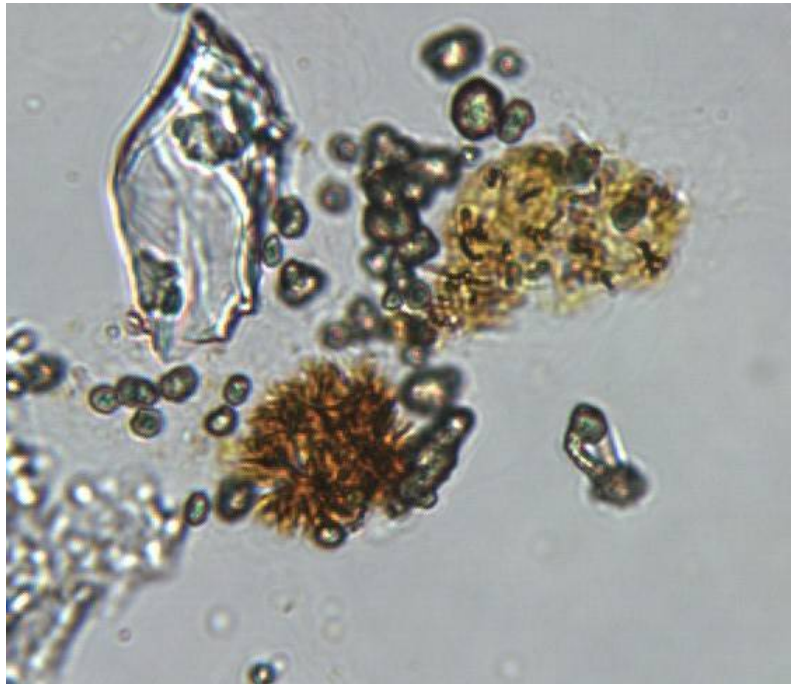
- Colorless or yellow-brown fine delicate needles



# Bilirubin Crystals

- Yellow-brown small clusters of needles or granules
- Must confirm with positive ictotest





- When bilirubin present in urine, indicates large amount of bilirubin is present liver disease

# Bilirubin vs Tyrosine Crystals

Bilirubin

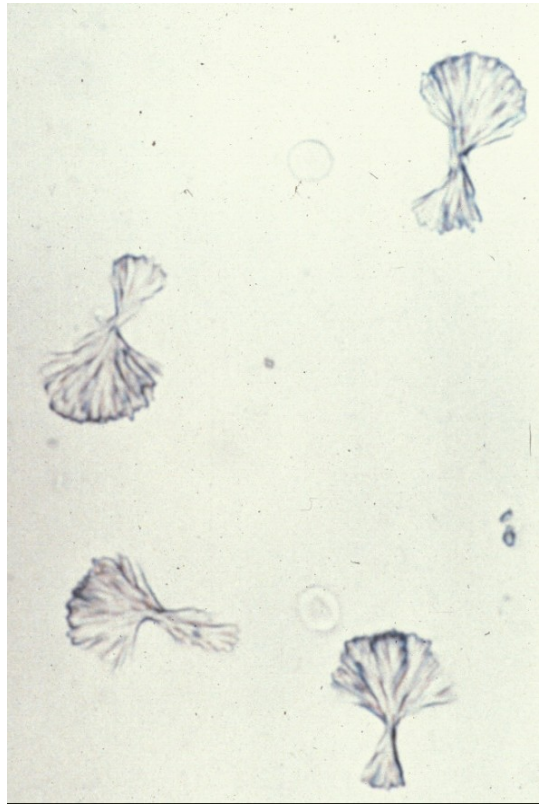
Thyrosine

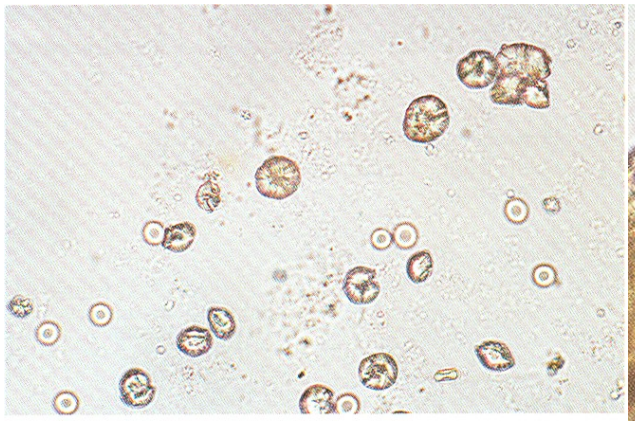
# Drug Induced Crystals

- Sulfonamides
- Radiographic dye (contrast media)

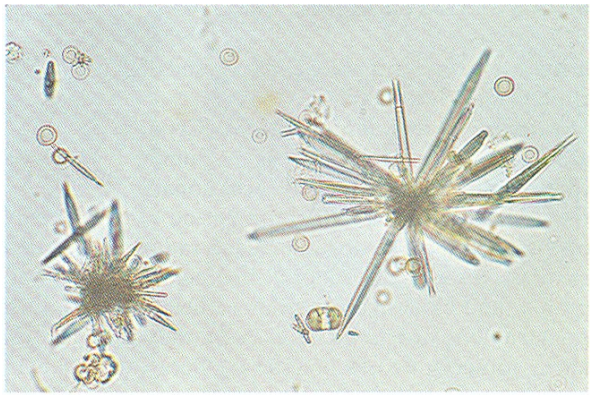
# Sulfa Crystals

- Form varies dependent upon the type of sulfa drug administered





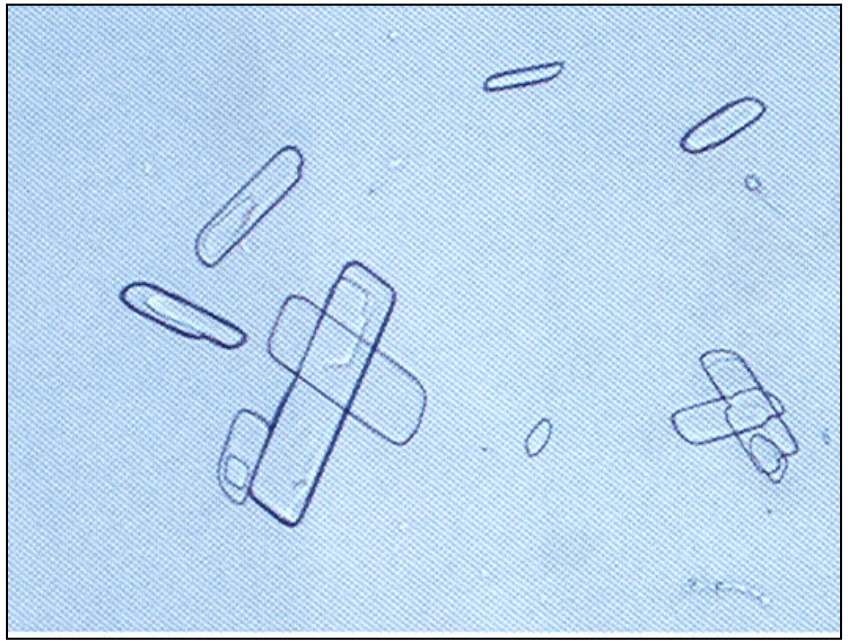
Sulfamethoxazole (Bactrim), and red blood cells, ×400.

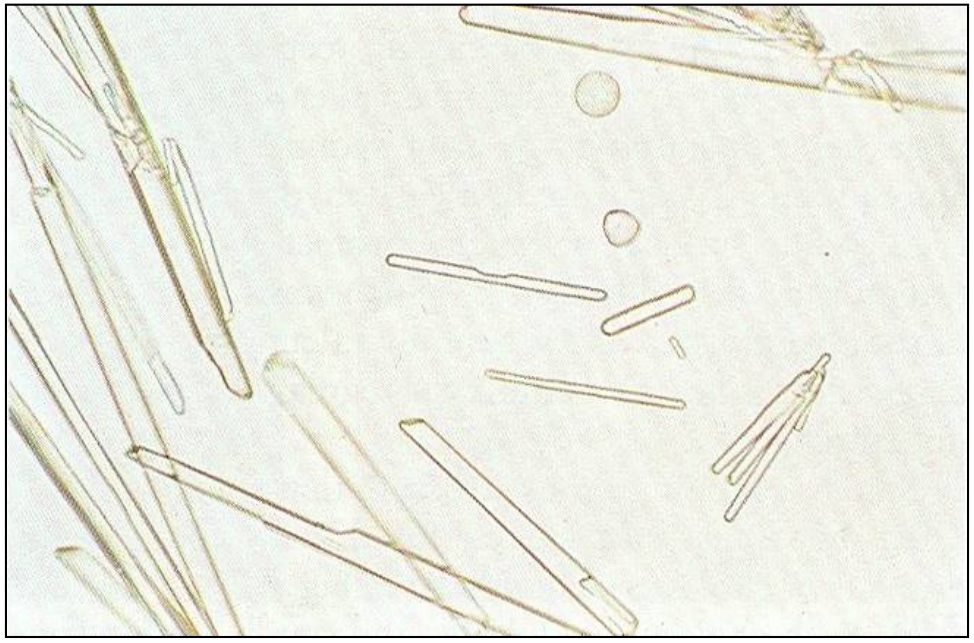


Sulfamethoxazole (Septra) rosette, and red blood cells, ×400.

# Radiographic Dye Crystals

- Also referred to as Contrast Media
- Colorless long pointed needles, or flat rectangular plates (resemble cholesterol crystals)
- Multicolored when polarized

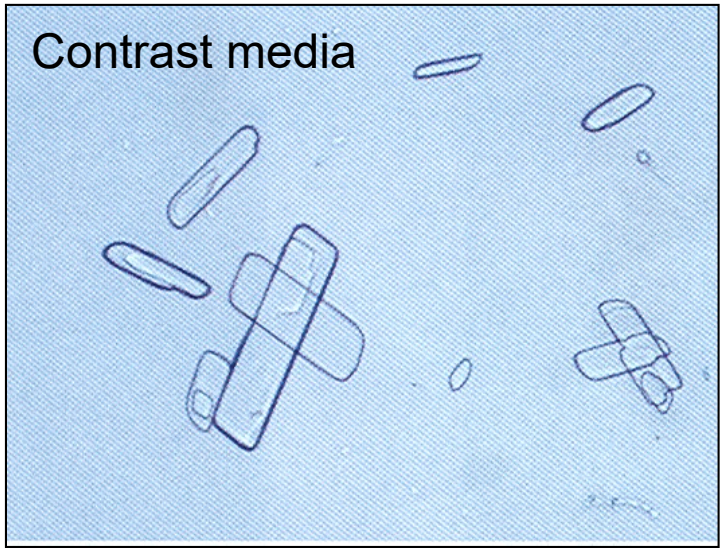


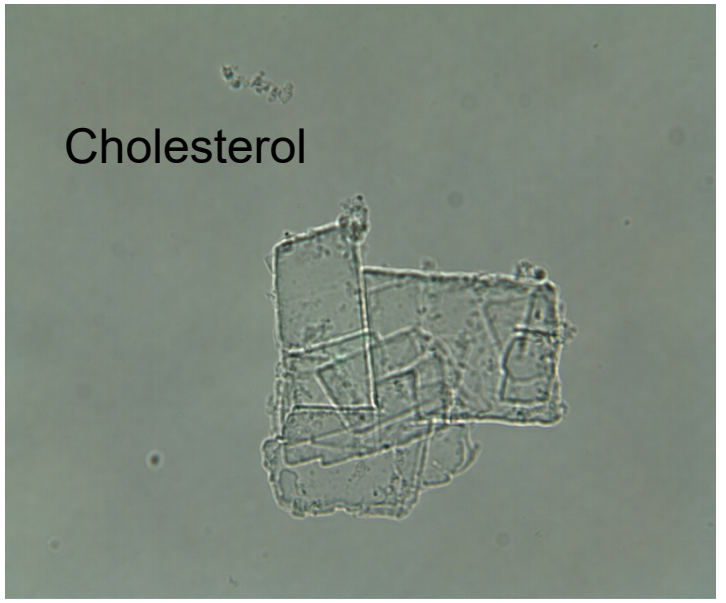


# Contrast Media vs Cholesterol

- Both crystals multicolored when polarized

- Contrast Media: specific gravity > 1.040



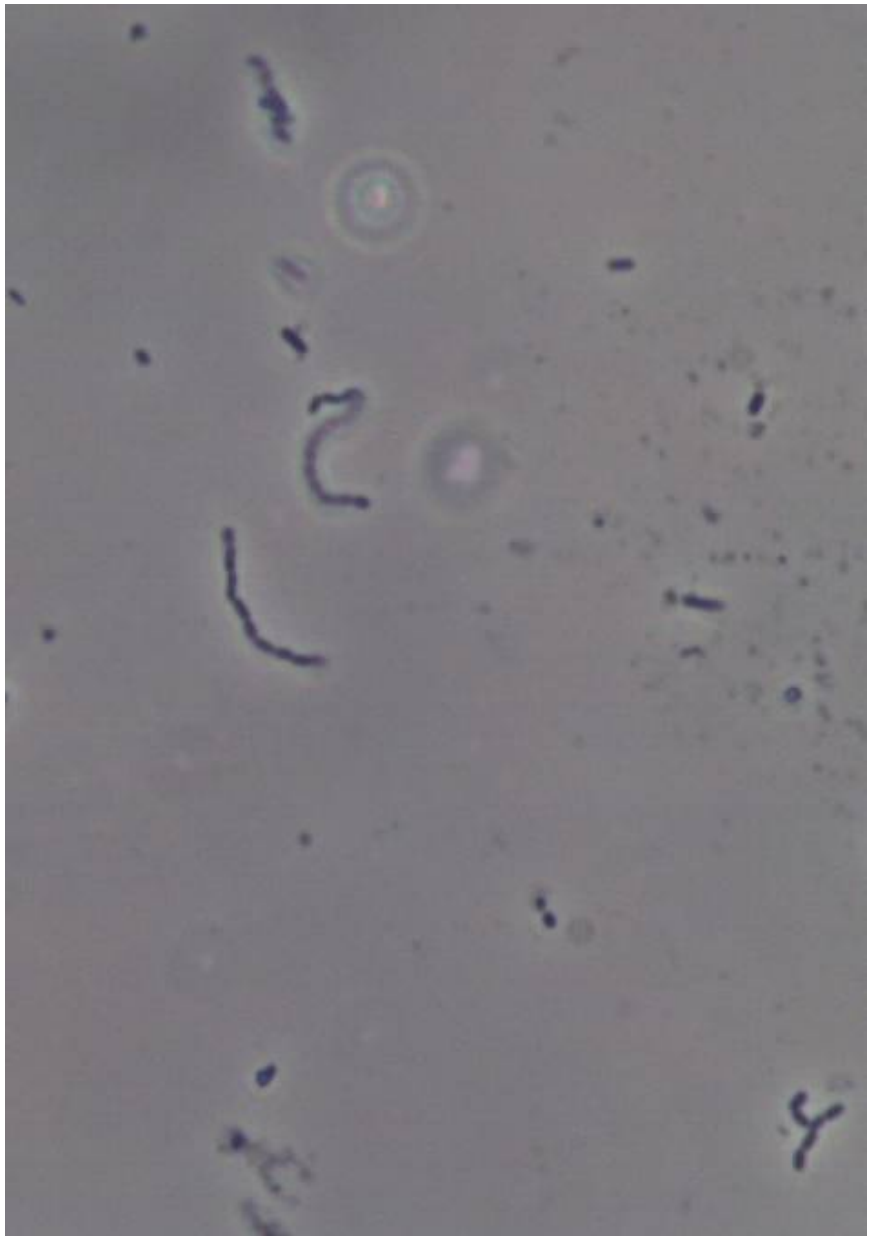



# Other Microscopic Elements

- Bacteria
- Yeast, mycelial elements (pseudohyphae)
- Fat
- *Trichomonas vaginalis*
- Sperm
- Mucus
- Starch, talc
- Fibers
- Glass, plastic

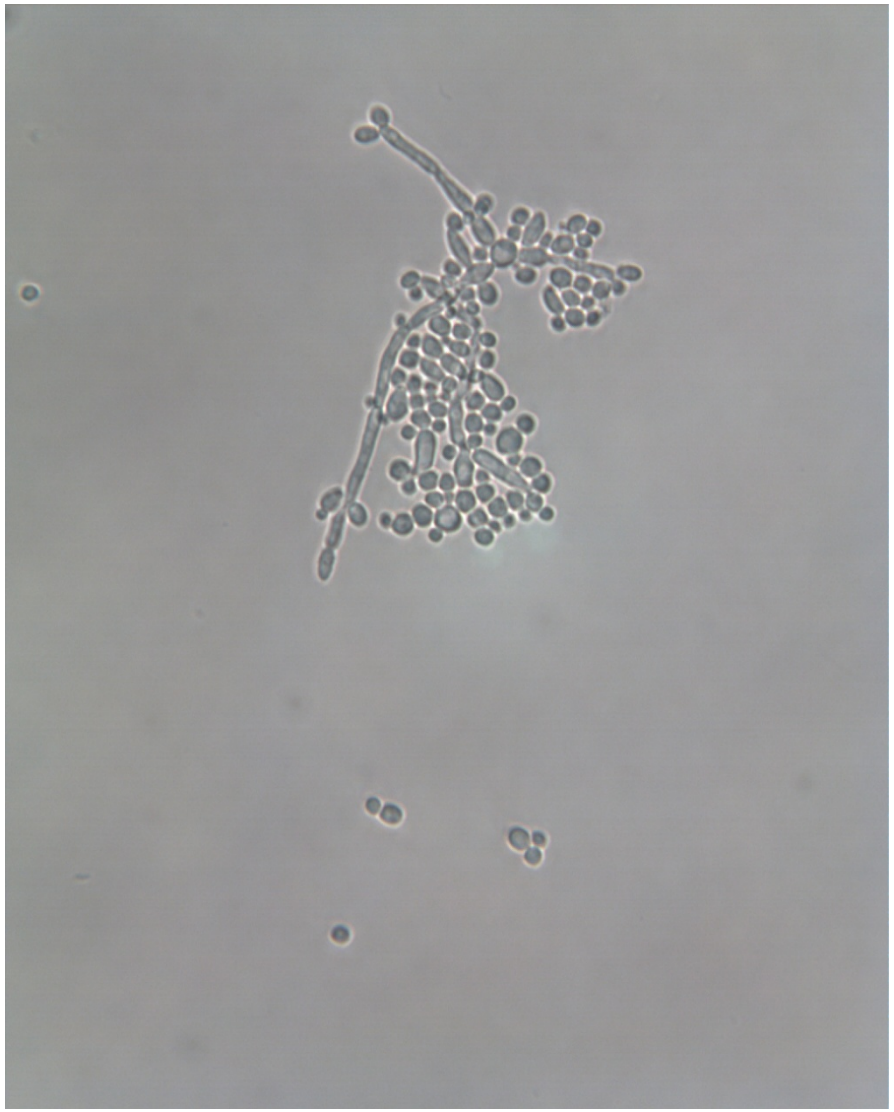
# Bacteria

- Most often rod-shaped
- Vary in size
- Must use high power objective
- Presence may indicate
  - UTI
  - Contamination
- Correlate with
  - Nitrite reagent strip

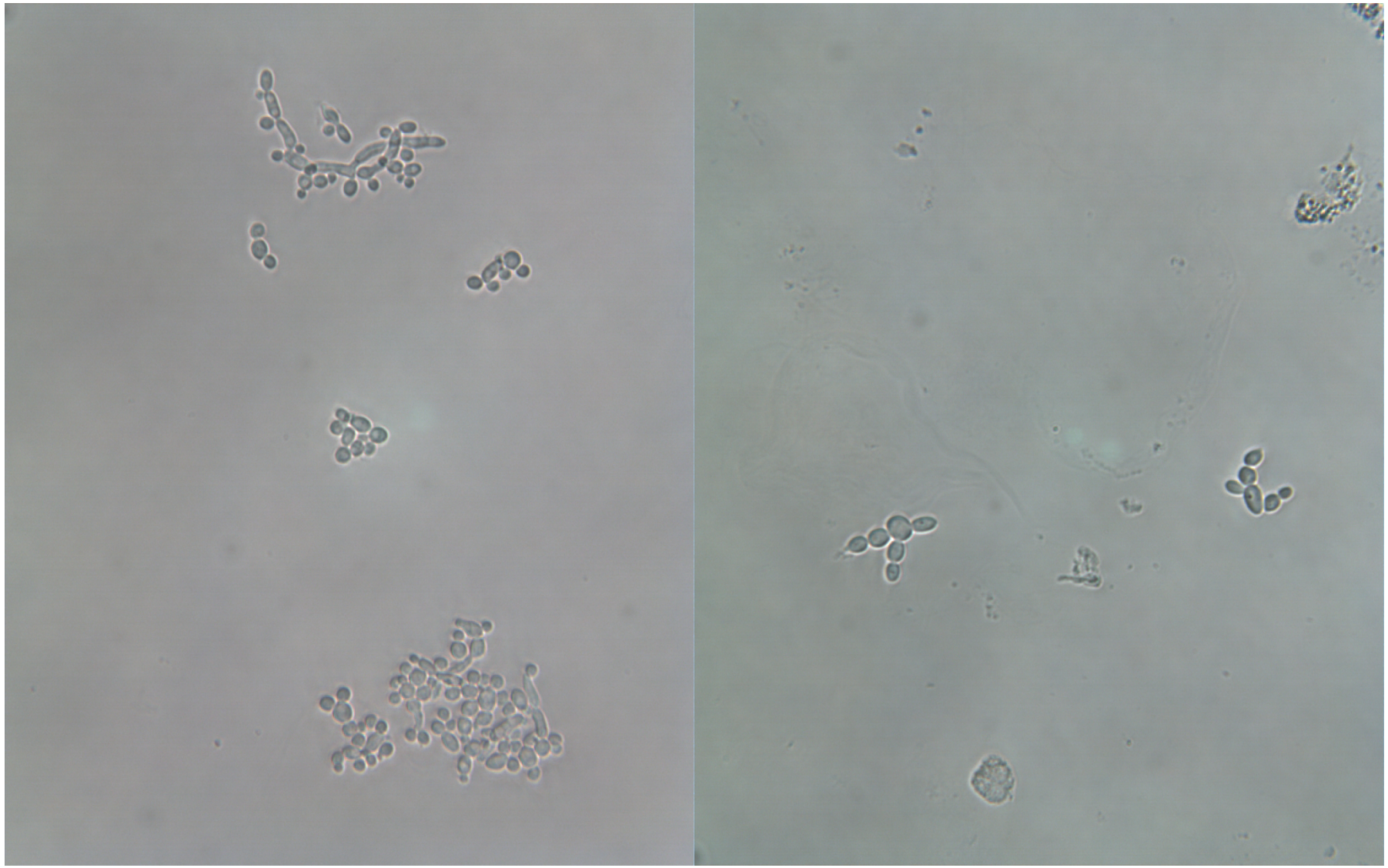


# Yeast and Mycelial Elements

- Budding forms or singly
- Ovoid and more refractile than RBC
- Will not lyse with acetic acid
- Note pseudohyphae

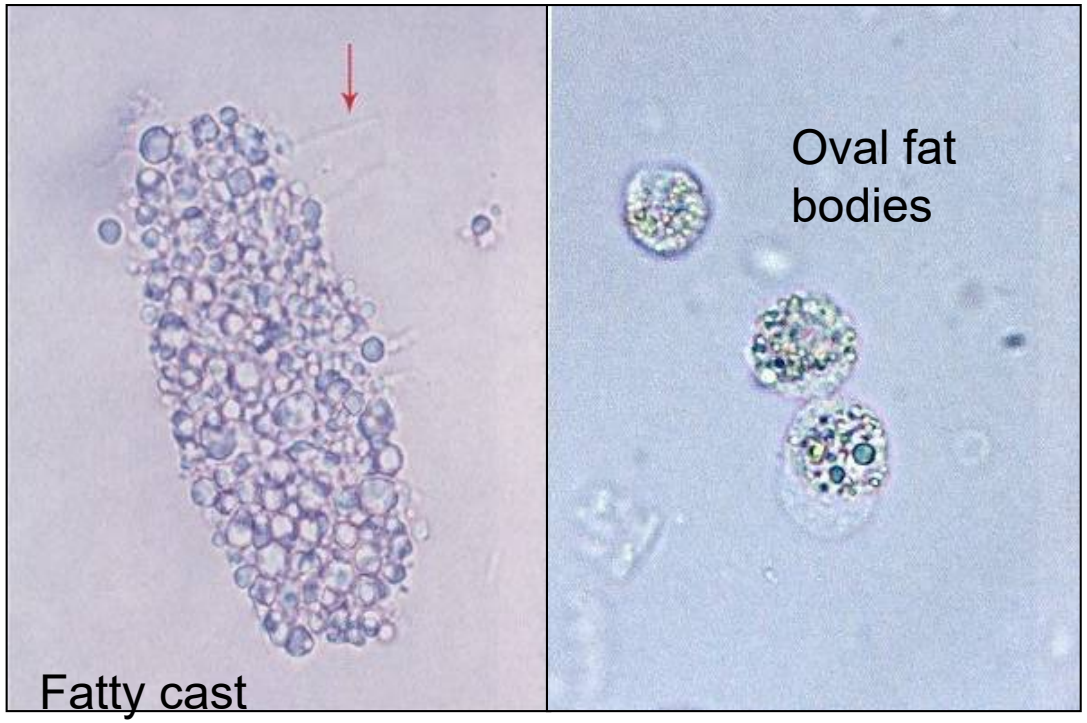


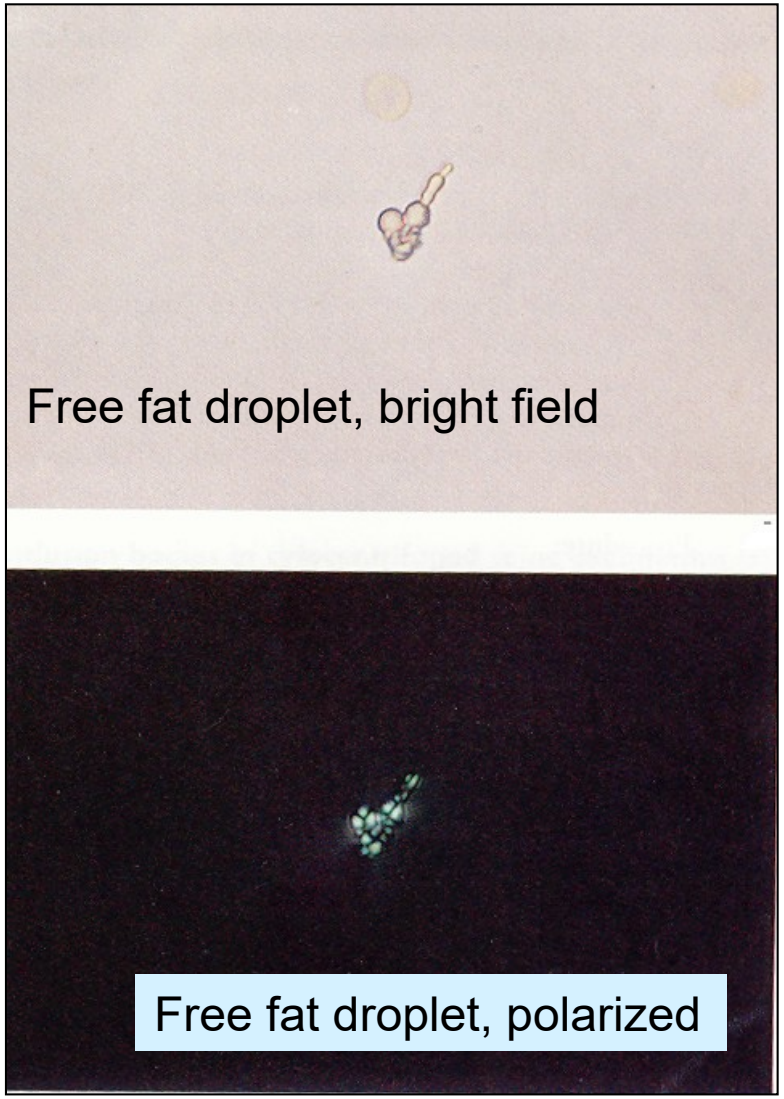
**HK's Urinalysis**



# Fat

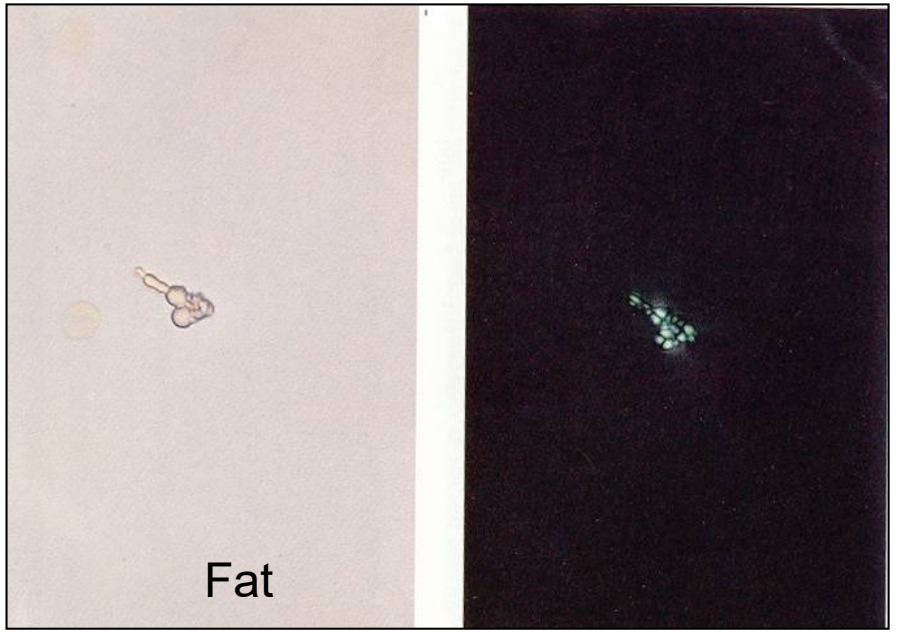
- Highly refractile
- Found in 3 forms:
  - Within fatty cast
  - Within oval fat body
  - Free fat droplet

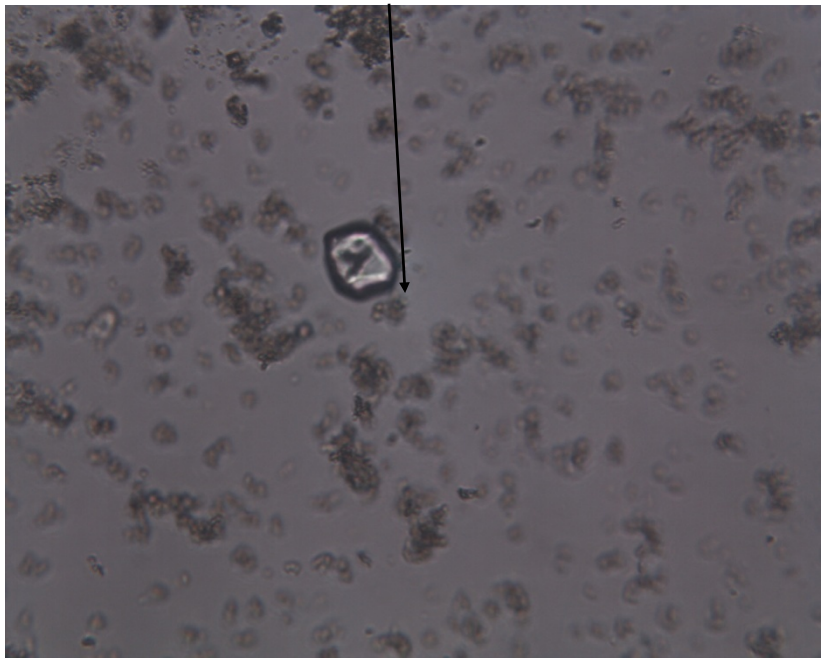


# Fat vs Starch

- Both polarize light
- Starch has characteristic central dimples



Starch

Starch

# Trichomonas vaginalis

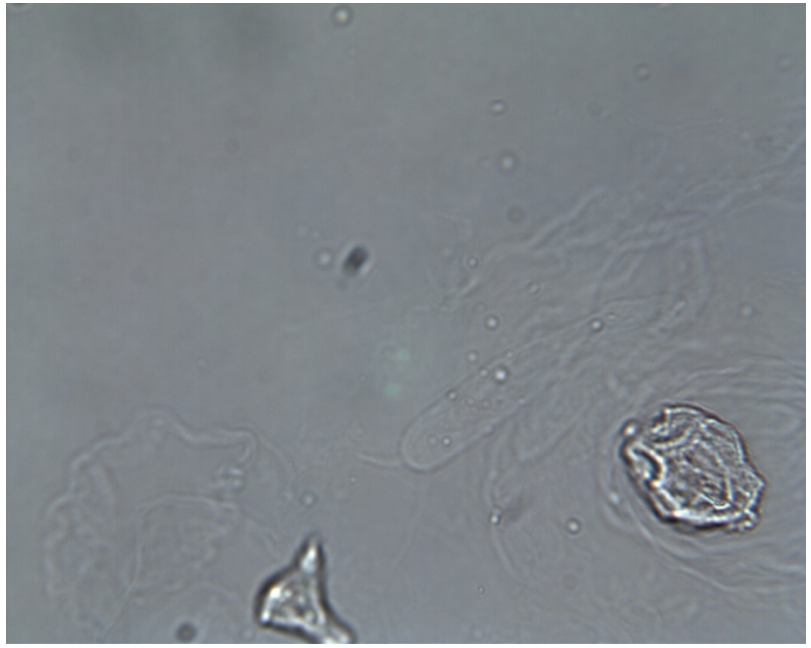
- Round to lemon-pear shape
- Undulating membrane and flagella provide movement
- Sexually transmitted
- Similar in size with WBC and RTE
- Can be confused with WBC

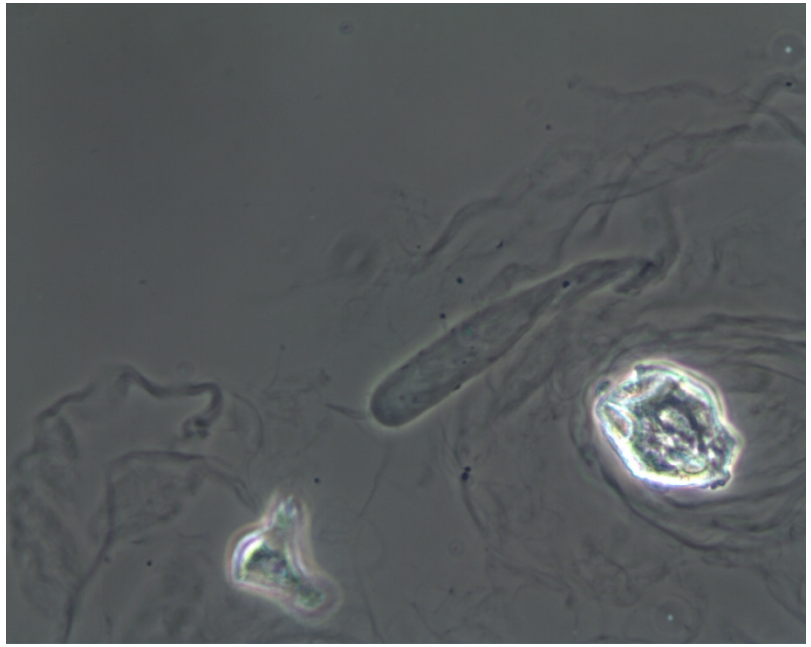
# Spermatozoa

- May be seen in male and female urine
- Usually not clinically significant unless
  - Post vasectomy
  - Rape
  - Child urine

# Mucus

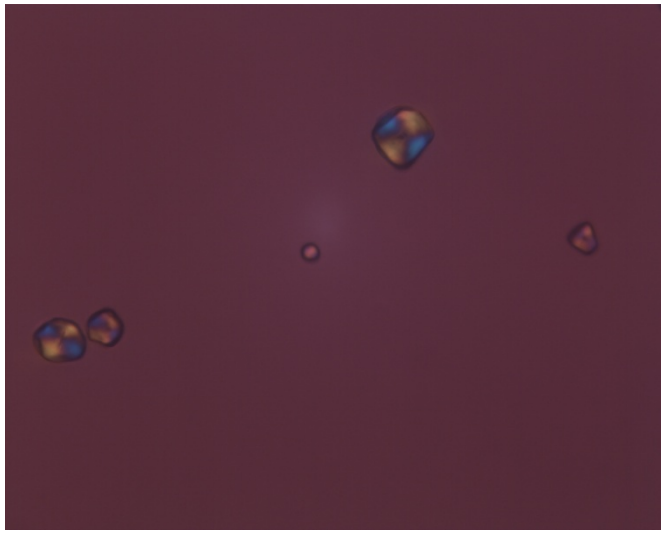
- Low refractive index makes it difficult to see
- Wavy, delicate ribbon-like strands or threads
- Can be mistaken for hyaline cast

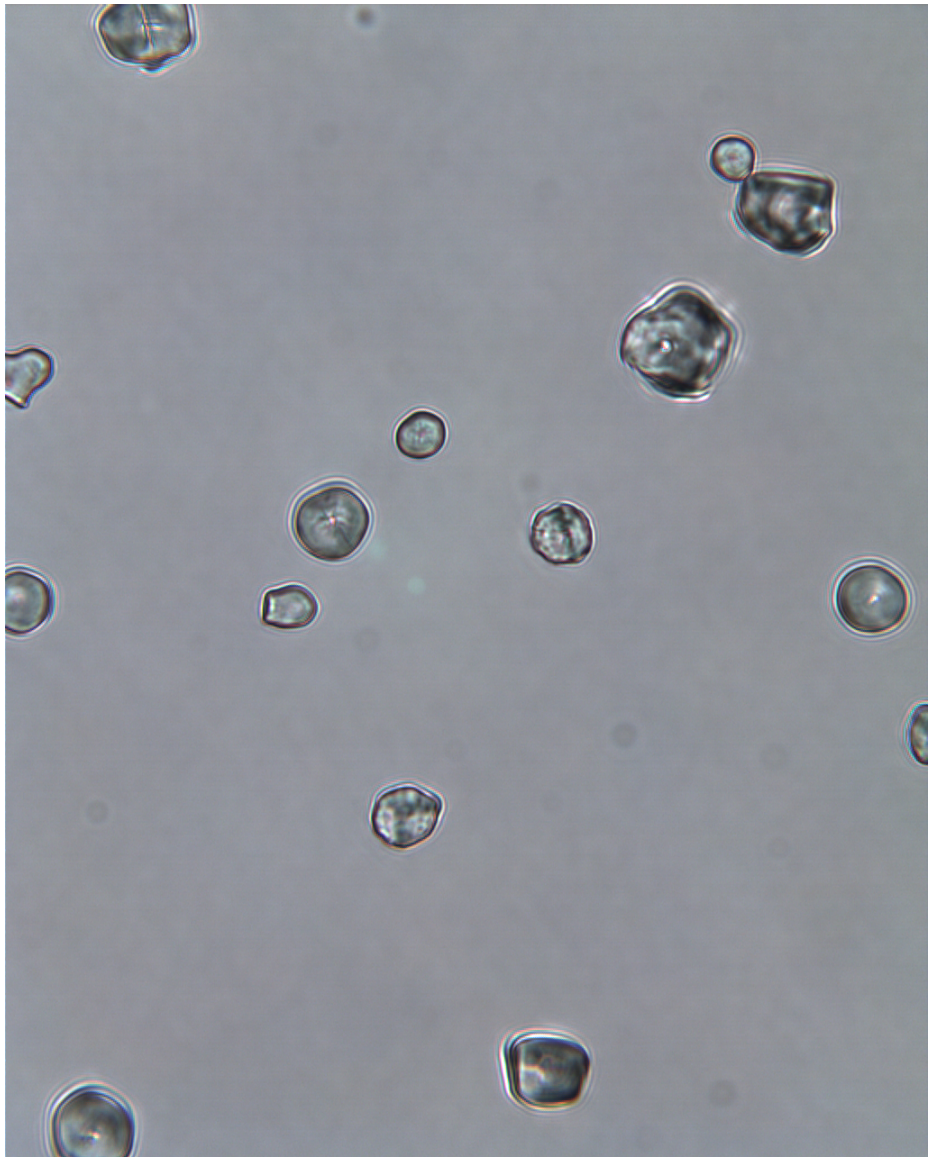




# Starch, talc

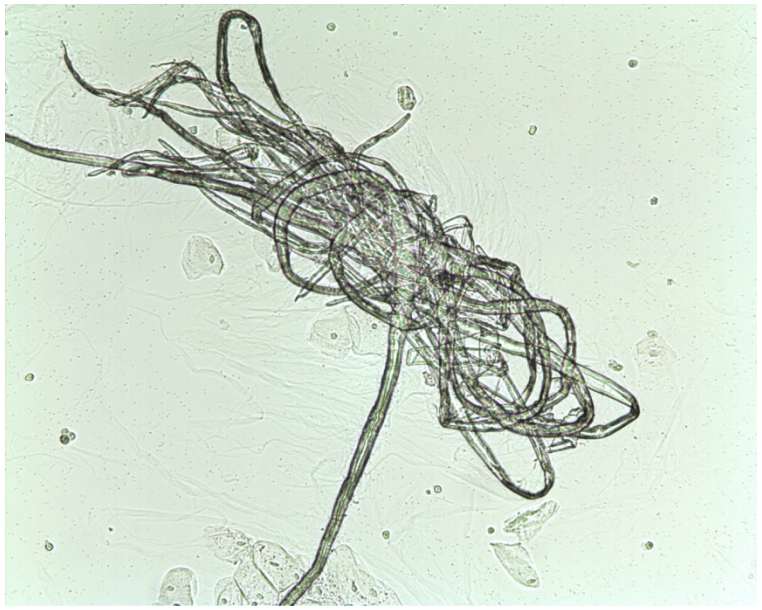
- Contaminant
- Varies in size and shape
- Characteristic central dimple



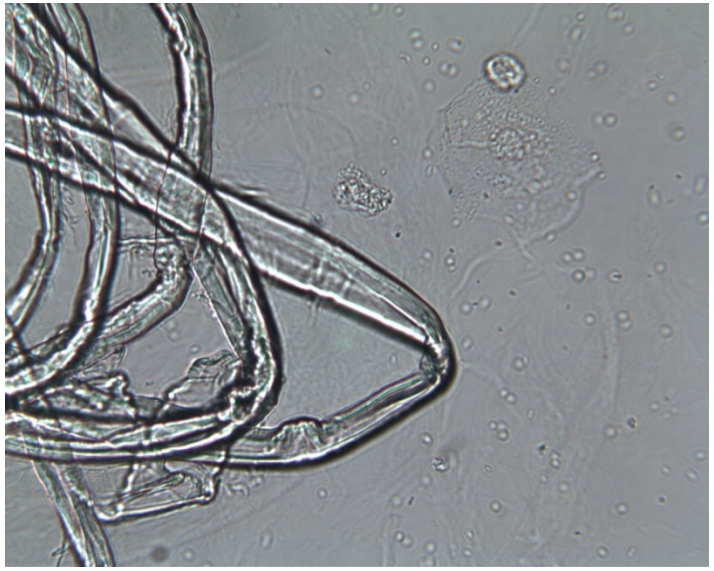


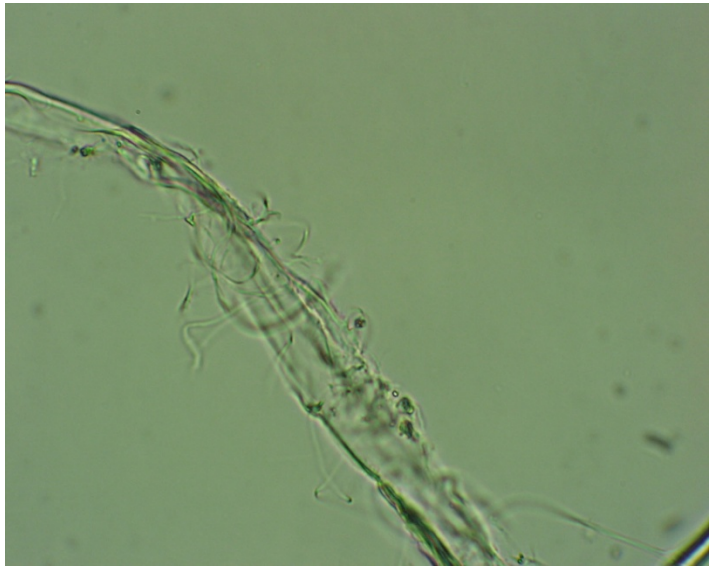
# Fibers

- Contaminant
- Large, with distinct edges
- Misidentified as casts



# Fibers





# Glass, Plastic

- Contaminant from
  - Glass cover slips
  - Plastic cover slips

- Misidentified as a crystal

# Principal sources of contamination of the urne

| Patient | Laboratory | Enviroment |
|---|---|---|
| Erythrocytes/leukocytes * | Starch | Pollen granules |
| Squamous epithelial cells | Glass fragments | Plant cells |
| Spermatozoa | Air bubbles | Fungal spores |
| Bacteria * | | *Alternaria* |
| Yeasts *(Candida)* | | *Helminthosporium* |
| *Trichomonas Vaginalis* | | *Epicoccum* |
| *Enterobius vermicularis* | | *Cladosporium* |
| Faeces | | |
| Pubic hair/hair | | |
| *Pediculosis pubis* | | |
| Fibres/Talcum powder | | |
| Oil /Creams | | |

*Contaminants when deriving from genital secretions