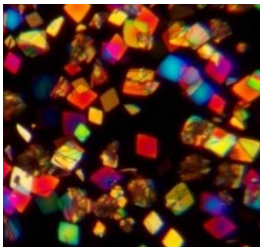
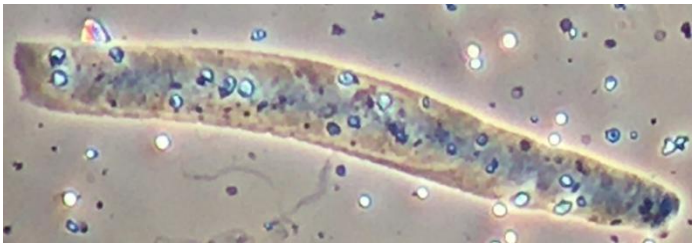
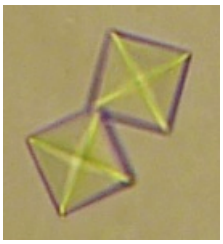
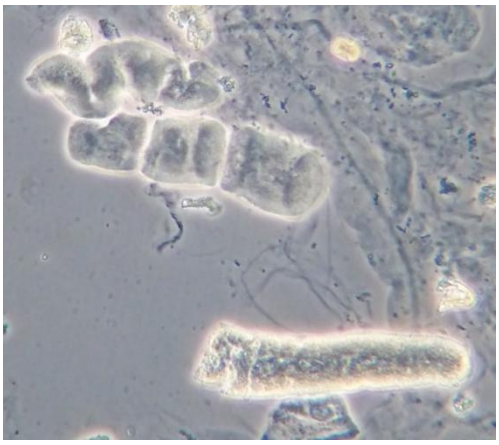
Microscopic Urine Examination, 2026 Bert Grijsen

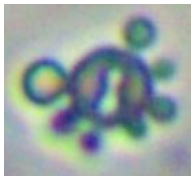
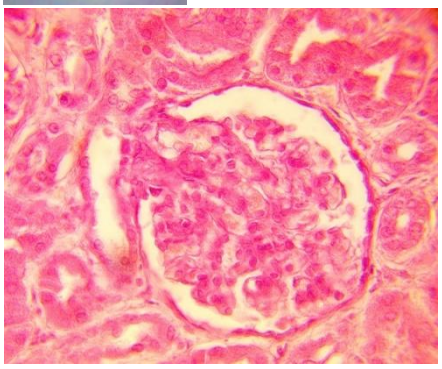
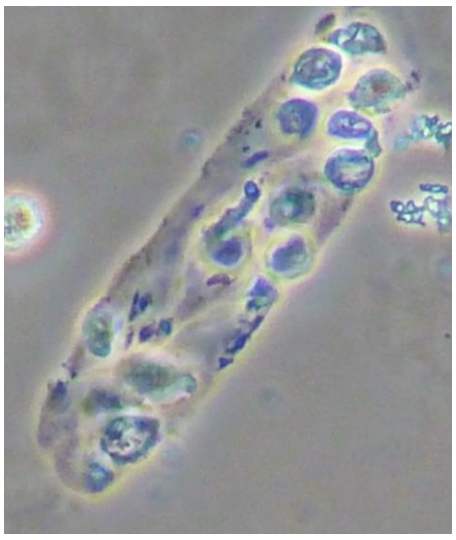
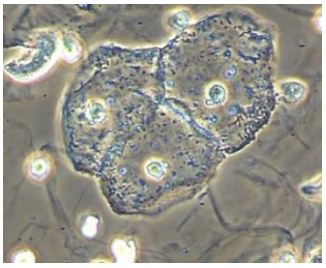
Chapter 1: Atlas of Urine Microscopic.

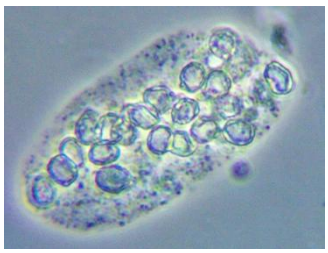
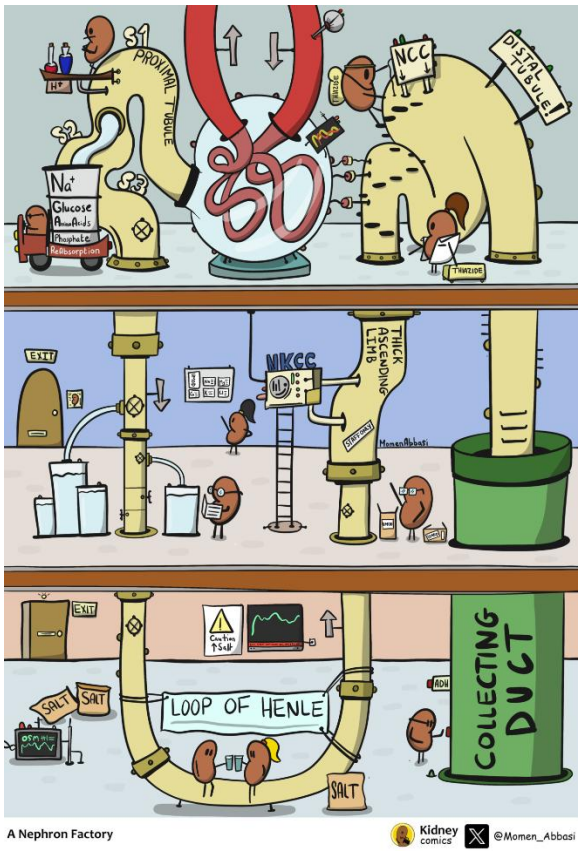
Chapter 2: Laboratory Diagnostics in Hematuria.

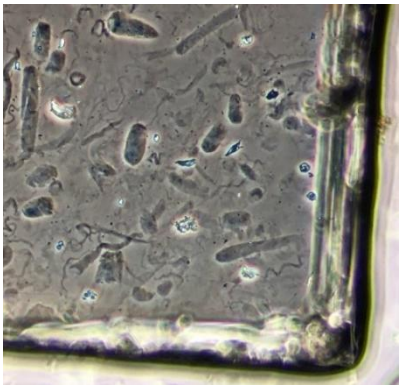
Chapter 3: Fiber in urine test, Entero-vesical fistula.



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Disclaimer:

This "Urine Atlas" is for informational purposes only and does not provide medical advice, diagnosis, or treatment. The possible conditions listed are general indications based on the test results **and are not a substitute for professional medical advice.**
Always consult a physician or qualified healthcare provider for a proper interpretation of the results and a professional medical assessment. We assume no liability for decisions made based on this information.

Contents	Page

Foreword:

This atlas was created out of enthusiasm for microscopy and the lack of sufficient photographic examples and background information regarding urine analysis, and particularly the assessment of sediments, for analysts in the laboratory. The first version, in 2011, was based on the CD, Diffex-Dus, produced by Radboud University Medical Center in Nijmegen, and was frequently used and appreciated by the analysts. In Hengelo, clinical chemists Ronald Maatman and René Niessen gave me the old light-field/phase-contrast/polarization microscope from the urine lab for home use, into which I installed a photo camera. In this way, I took hundreds of example photos at home and in the lab. After some difficult choices, these were suitable for presentations. This newly improved fourth edition, Microscopic Urine Examination 2026, was reviewed by Ronald Maatman, clinical chemist and head of the urine laboratory department at Medlon, part of Unilabs. Hopefully, with this freely accessible atlas, I can meet the needs of many analysts and other interested parties for the correct performance and evaluation of microscopic urine examination.

Chapter 1: Contains microscopic images of the most common components in a urine sediment.

Chapter 2: Provides additional explanation and explains the importance of hematuria examination in distinguishing between a urological and nephrological cause of red cell loss in urine.

Chapter 3: Provides additional explanation and explains the importance of detecting fibers in urine in the presence of an entero-vesical fistula.

My special thanks go to:
Ronald Maatman, E.B. Cornel (former urologist ZGT), G.B. Fogazzi, L.B. Hilbrands, Federation of Medical Specialists (FMS), Dutch Association of Urology (NVU), Dutch Association of Clinical Chemistry (NVKC), Dutch Association of BioMedical Laboratory Staff (NVML), Roche Netherlands, Renal Fellow Network (RFN): Matthew Sparks, Momen Abassi, José Tesser Poloni (Controllab) and Jay Seltzer, Radiology ZGT and of course my closest colleagues at the Medlon laboratory location, ZGT in Almelo.

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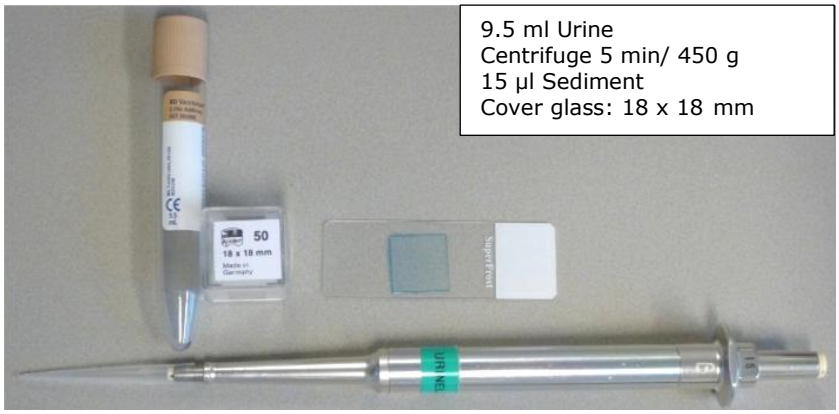
Chapter 1: Atlas of Urine Microscopic.

Clinical Significance of Urine Examination:

Urine is formed as an ultrafiltrate of blood plasma in the kidneys. It is therefore the primary medium through which the body eliminates excess water and dissolved salts, along with numerous metabolic end products and foreign substances such as medications.
In addition to these chemical components, urine may also contain a number of biological structures in the form of (blood) cells, bacteria, parasites, etc.
If the urine sediment contains one or more organized microscopic components, this may indicate a disease, for example, of the kidneys or bladder. Only those components that may be indicative of the presence of a disease process are identified:

- Leukocytes
- Erythrocytes
- Renal Tubular Epithelial Cells (RTEC).
- Casts
- Crystals
- Bacteria
- Parasites/Amoebas
- Fungi/Yeast
- Fibers



Set aside the samples from which sediment is to be collected.

- Mix the urine sample thoroughly by turning it upside down several times (ensure that the screw cap is securely tightened).
- Identify a yellow 9.5 mm urine tube and fill it with urine.
- Centrifuge the tubes for 5 minutes at 400-450 g without inhibition at room temperature.
- Decant the tubes.
- The sediment volume should be between 0.25 and 0.50 ml.
- If necessary, add 0.9% sodium chloride using a dropper.
- Gently mix the sediment by hand.
- Transfer 15 µl of the sediment to a slide using a pipette.
- Cover the sediment on the slide with an 18 x 18 mm coverslip.

Fixing sediment:

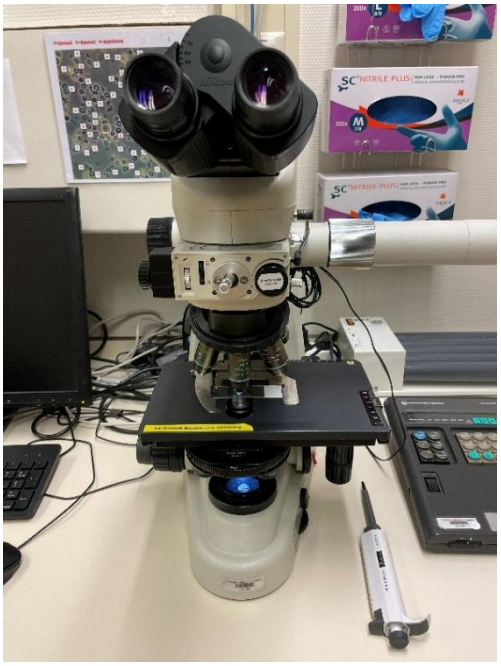
If a slide is not being prepared immediately, add 1 drop of 25% glutaraldehyde to the sediment using a Pasteur pipette for preservation and mix.
Cap the tube until evaluation. Shelf life: 3 months.

Evaluating a sediment[1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 13]:

- Place the slide containing the sample under the microscope.
- Image using a 10x objective.
- Identify using the 40x objective.
- Search for diagnostically significant elements in at least 10 fields of view.
- Count the number of elements per field of view.
    - o For greater contrast in general, but especially for counting casts, examine the sediment using a phase-contrast microscope.
    - o Count the number of casts using a 10x objective. Use a 10x objective lens in 10 fields of view(pfov) and switch to the 40x objective lens for identification.
    - o If more erythrocytes and/or leucocytes are observed in the sediment than the strip measurement indicates, report the sediment test result; change erythrocyte/leucocyte in GLIMS.

- Use the optional texts with CTRL F.
- Have a second person assess the sample; if necessary, fix the sediment if it cannot be assessed immediately by a second person.

Element Number:	pfov	Glims /ul	pfov	Glims /ul	pfov	Glims /ul	pfov	Glims /ul	Objective
Leukocytes	0-2	<10	3-10	10-50	10-30	50-150	> 30	>150	40x
Erythrocytes	0-2	neg	3-10	10-50	10-30	50-150	> 30	>150	40x
Erythrocyte casts	-	neg	>0-2	ERY 1+	3-5	ERY 2+	> 5	ERY 3+	10x
Hyaline casts	Up to 1	neg	1-2	HYA 1+	3-5	HYA 2+	> 5	HYA 3+	10x
Granular casts	Up to 1	neg	1-2	GRA 1+	3-5	GRA 2+	> 5	GRA 3+	10x
Leukocyte casts	-	neg	>0-2	LEU 1+	3-5	LEU 2+	> 5	LEU 3+	10x
Renal Epithelial casts	-	neg	>0-2	EPIT 1+	3-5	EPIT 2+	> 5	EPIT 3+	10x
Fatty casts	-	neg	>0-2	FAT 1+	3-5	FAT 2+	> 5	FAT 3+	10x
Waxy casts	-	neg	>0-2	WAX 1+	3-5	WAX 2+	> 5	WAX 3+	10x
Crystals	-	neg		A few		Multiple		A lot of	40x
Bacteria	< 20	neg					> 20	pos	40x
Yeast cells	-	neg					+	pos	40x



Evaluation of Hematuria /Glomerular Hematuria:

The presence of erythrocytes in urine can be an indication of pathology.

There are two guidelines regarding hematuria:

1. The Dutch Society for Clinical Chemistry (NVKC):
Use urinalysis to distinguish between mono- and dysmorphic hematuria for referral to a urologist or nephrologist.

2. The Dutch Society for Urology (NVU):
Use urinalysis to select patients with possible urological malignancy for additional imaging.
The urological guideline requires confirmation of the hematuria detected by the urine screen. Additional microscopic examination:
If more than 3 erythrocytes are present in the field of view at 400x magnification, a morphological assessment of the percentage of dysmorphic erythrocytes and acanthocytes out of a total of 200 erythrocytes and the presence/absence of erythrocyte casts is performed. In accordance with the FMS guideline: Unambiguous and accurate laboratory diagnosis of hematuria. See the table below with the corresponding conclusions. If the field of view contains less than 3 erythrocytes with the presence of dysmorphic and- or acanthocytes, the following report is made: Due to the low number of erythrocytes in the field of view in the sediment, quantification of the abnormal erythrocytes is unreliable.

Use the choice texts, and after validation the conclusion will be 'calculated' and reported.

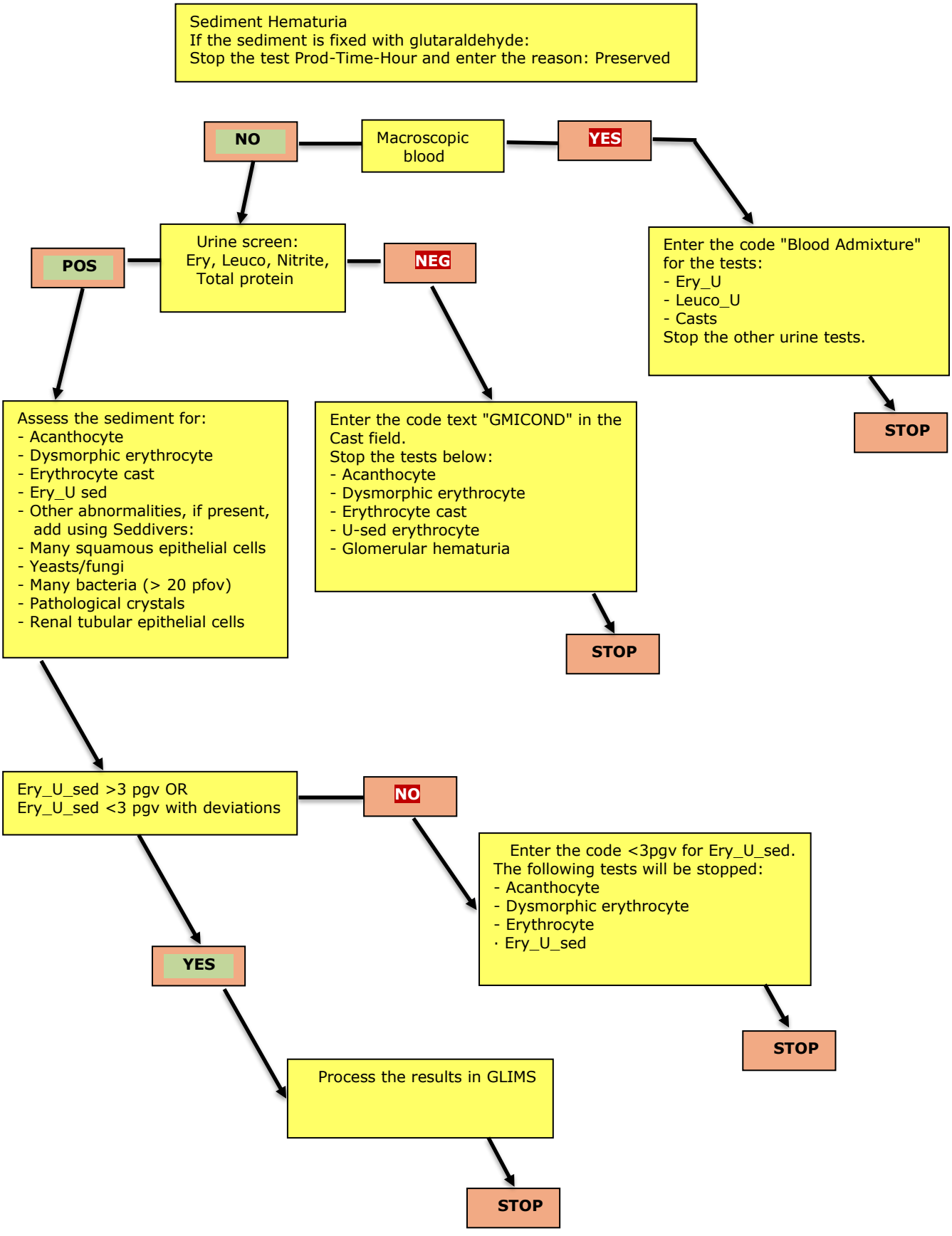
% Dysmorphic erythrocytes	% Acanthocytes	Erythrocyte cast	Conclusion
0 - 5	0 - 3	absent	Isomorphic erythrocyturia consistent with lower urinary tract hematuria.
< 40	< 5	absent	Glomerular hematuria unlikely.
< 40	< 5	present	No clear distinction can be made between glomerular hematuria and non-glomerular hematuria; possible mixed symptoms.
< 40	> 5	absent	No clear distinction can be made between glomerular hematuria and non-glomerular hematuria; possible mixed symptoms.
< 40	> 5	present	No clear distinction can be made between glomerular hematuria and non-glomerular hematuria; possible mixed symptoms.
> 40	< 5	absent	Possible glomerular hematuria.
> 40	< 5	present	Probably glomerular hematuria.
> 40	> 5	present	Probably glomerular hematuria.

Within the established conclusion criteria, we assess and report the following percentages for the dysmorphic abnormalities present as additional information:

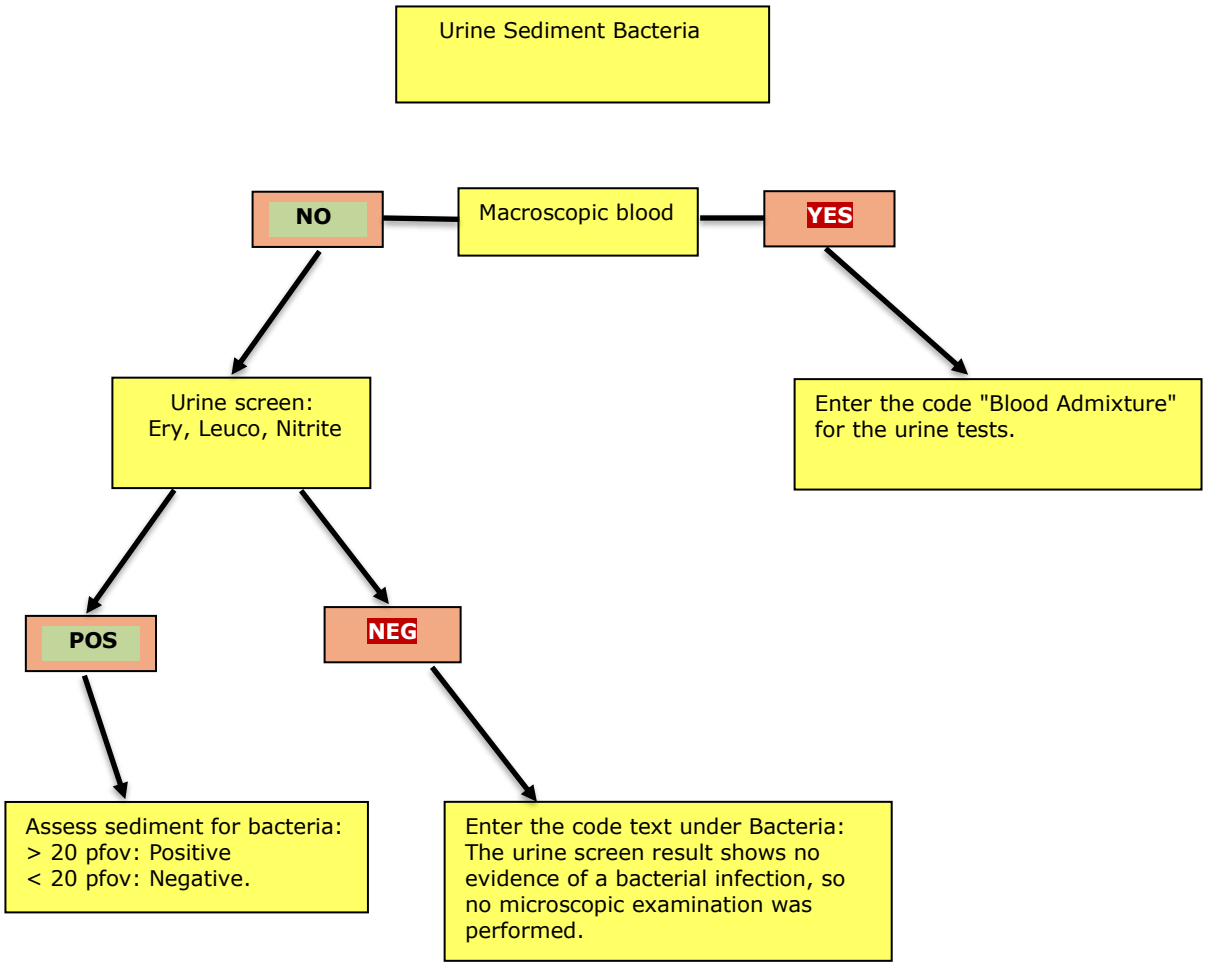
% Dysmorfic erytrocytes
0 - 5
5 - 25
25 - 40
> 40

% Acanthocytes
0 - 3
3 - 5
> 5

Urine Hematuria Assessment Flowchart[1, 2, 7,8,10,13]:



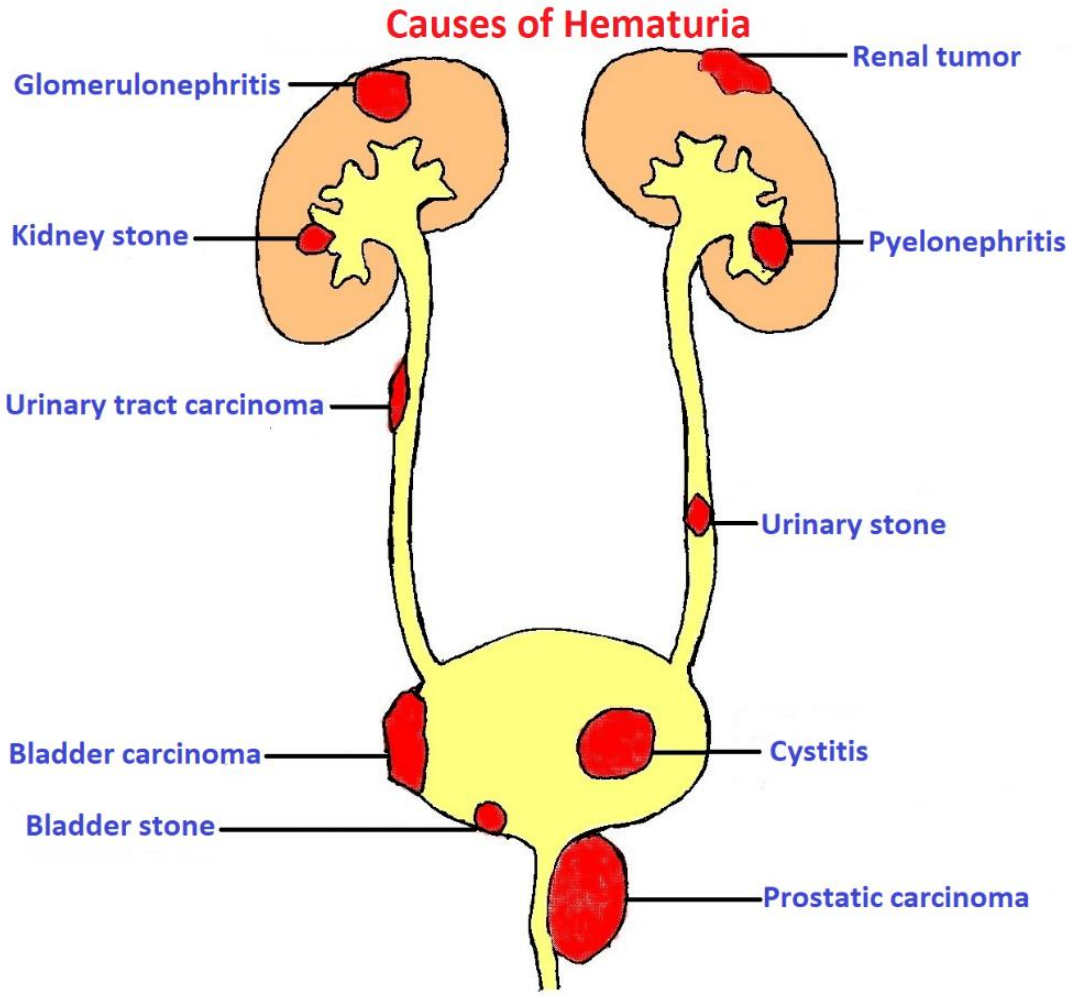
Urine Bacteria Assessment Flowchart[3,4,5,6]:



Erythrocytes:

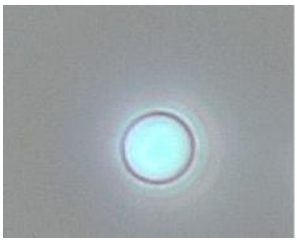
Erythrocytes are visible as small, round cells with a diameter of approximately 7 µm. The cells are biconcave without granulation or a nucleus. A characteristic of erythrocytes is the central indentation (like a tire), unlike yeast or air bubbles. If the erythrocytes originate from the urinary tract (bladder, ureter, renal pelvis), they have a smooth cell membrane. The cells do not vary significantly in size and present a monotonous (isomorphic) appearance. In highly concentrated urine, the erythrocytes may be shrunken due to the high osmolarity (like a thorn apple). If the erythrocytes enter the urine through leakage through the glomerulus (e.g., nephritis), they often have bizarre shapes and are often smaller than normal. The appearance is variegated (polymorphic), and these are called dysmorphic erythrocytes.

Clinical significance: Hematuria (erythrocytes >10/µL or >3/ pfov) can have a renal, glomerulonephritis, postrenal (particularly bladder or prostate carcinoma, kidney stones, or urinary tract infection), or extrarenal cause (coagulation defects, medications). In many cases, no cause for the (micro)hematuria can be found. A large number of erythrocyte casts indicate nephrogenic kidney disease, particularly glomerulonephritis; proteinuria and erythrocyte casts are almost always present.
In adults, it is seen with kidney stones, bladder carcinoma, and prostatic hypertrophy; in children with Alport syndrome, IgA nephropathy, or as a benign familial phenomenon.
Intact erythrocytes without proteinuria and erythrocyte casts are primarily found in postrenal hematuria: urinary tract disorders. Erythrocyte casts can also be observed in cases of bacterial endocarditis, sepsis, and after strenuous physical exertion.
If glomerular hematuria is suspected, a glomerular hematuria test can be requested. If erythrocytes are detected in the urine (with strip measurement), the sediment is microscopically assessed for dysmorphic erythrocytes, acanthocytes, and erythrocyte casts. The conclusion is reported in accordance with the FMS guideline, "Unambiguous and Accurate Laboratory Diagnosis of Hematuria."

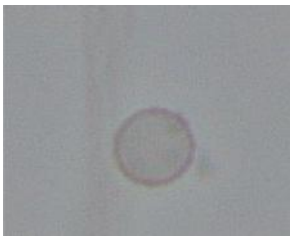


Erythrocytes Isomorphic[1]:

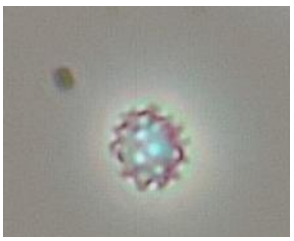
- Biconcave disc shape:



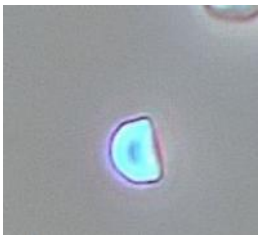
- "Ghosts", even outline:



- Osmotic changes,
  -swollen or thorn apple:



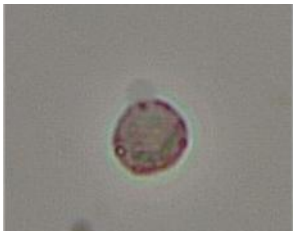
- "Bitten Cell":



Erythrocytes Dysmorphic[1]:

- Annular shape,
  -bicycle tire/donut:

- Dense aggregaten
  in cytoplasma:

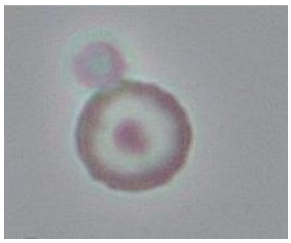


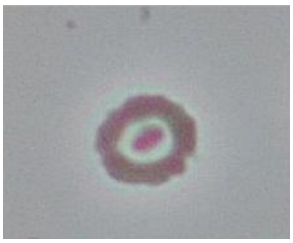
- Irregular cytoplasm
  and/or membrane:

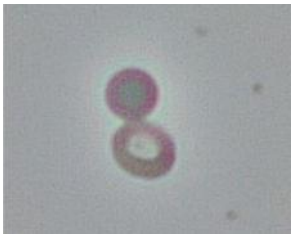
- Severely damaged by
  lysis or mechanical effects:

Erythrocytes Acanthocytes[1]:

- **Erythrocytes with vesicles/projections to the outside or inside: Mickey mouse cells.**
- **More than 5% acanthocytes, specificity of 98% / sensitivity 52% for glomerular hematuria!**

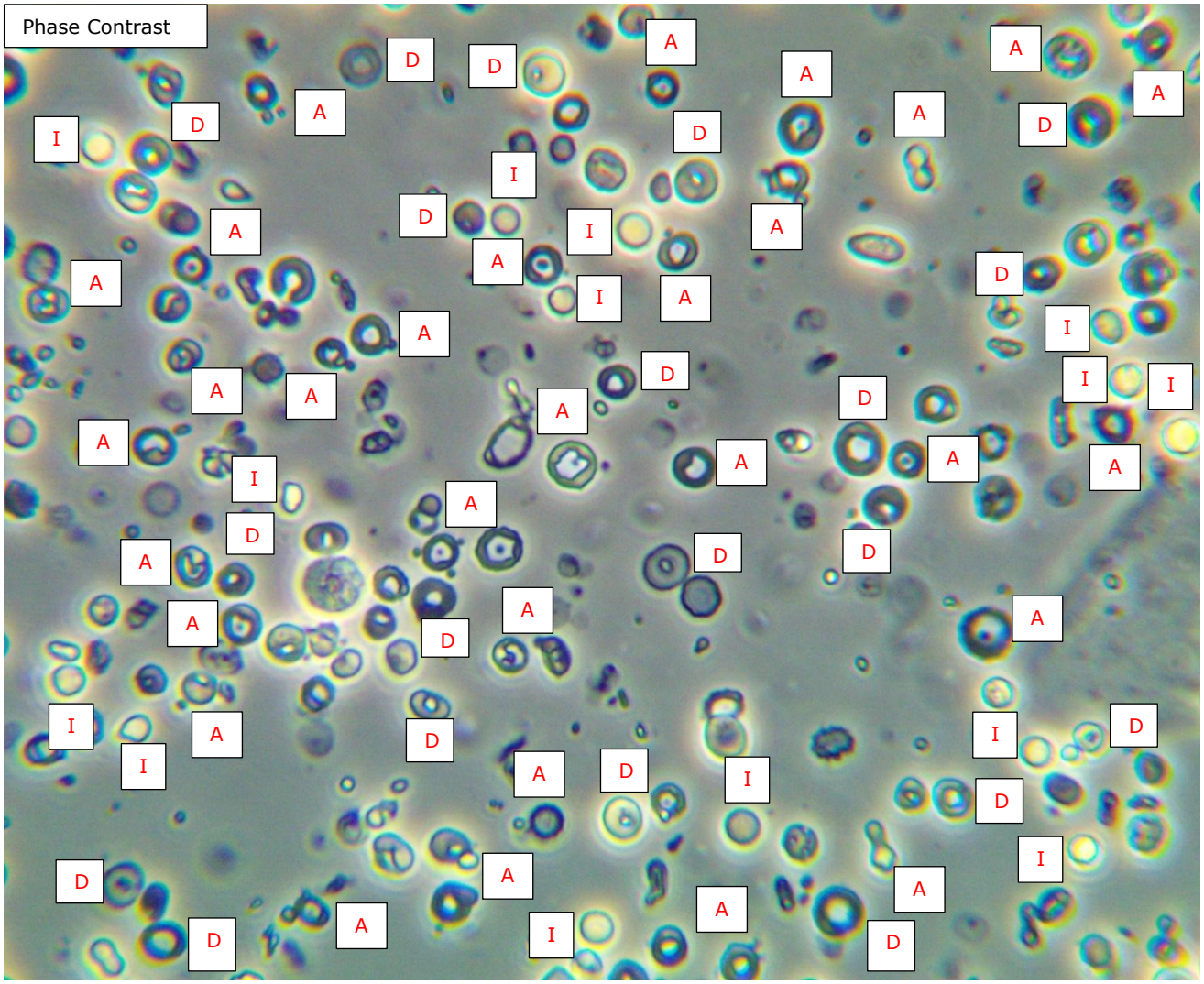


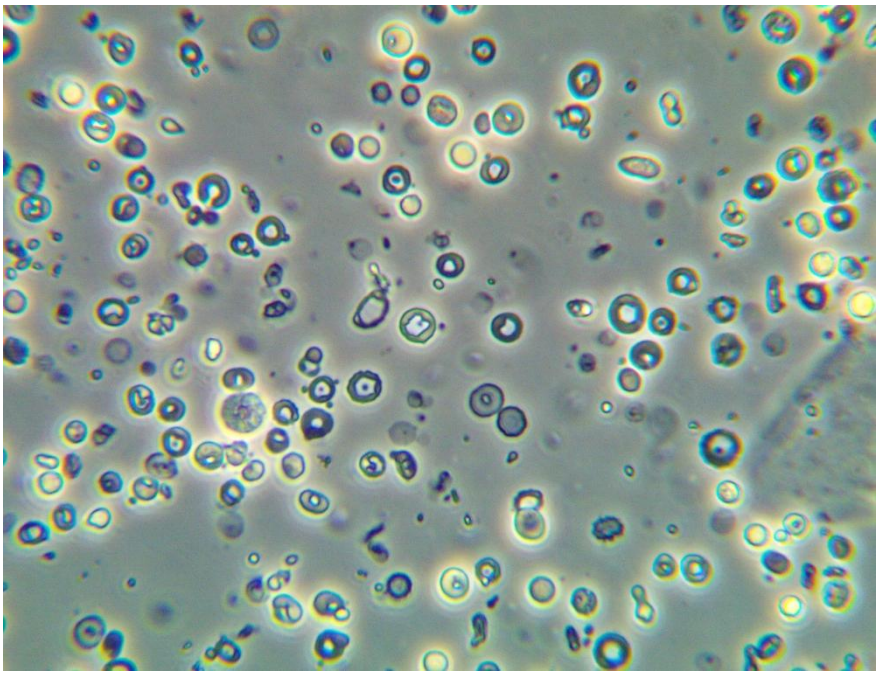




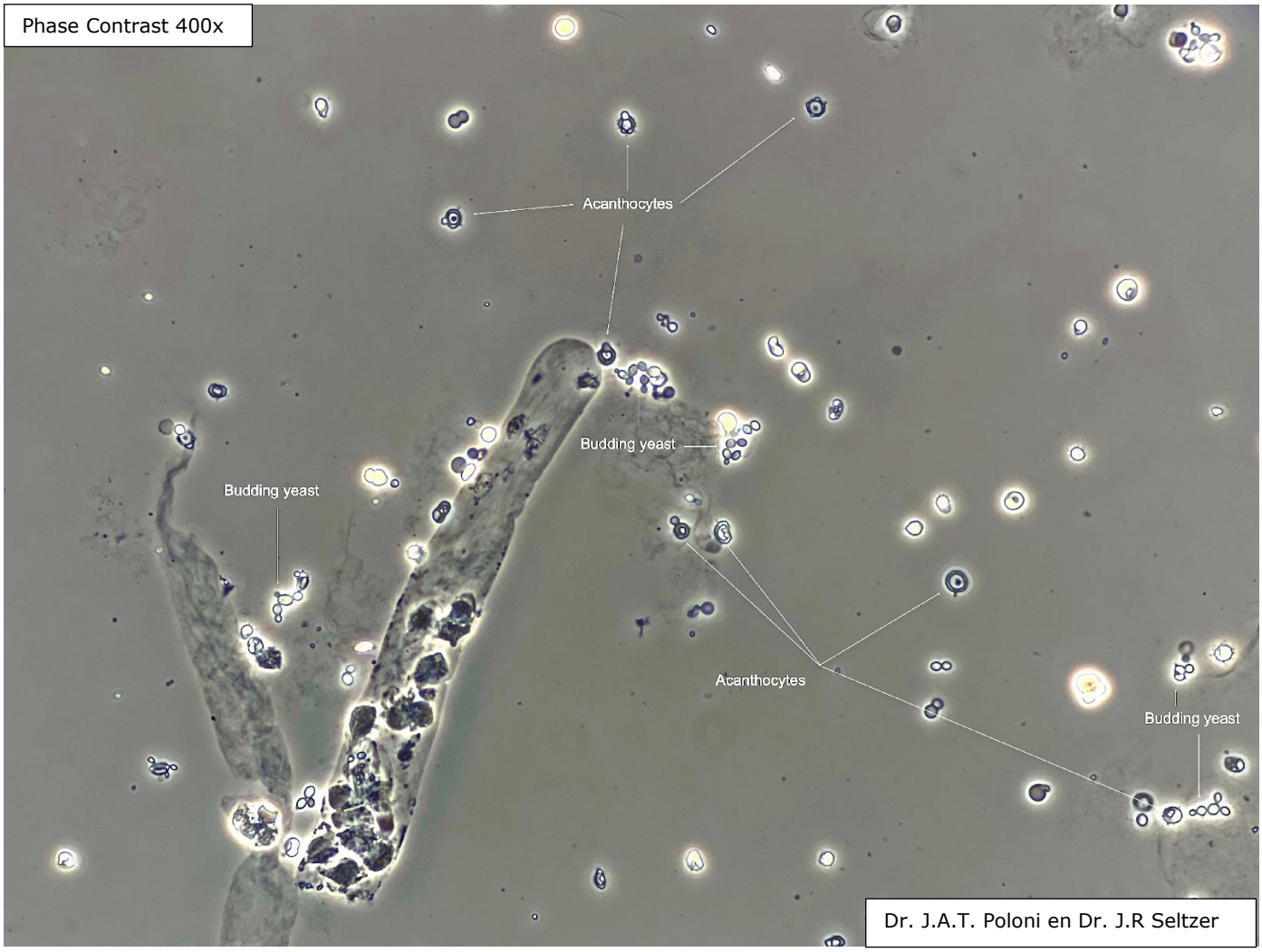
Patient example Erythrocytes, Isomorphic, Dysmorphic and Acanthocytes:

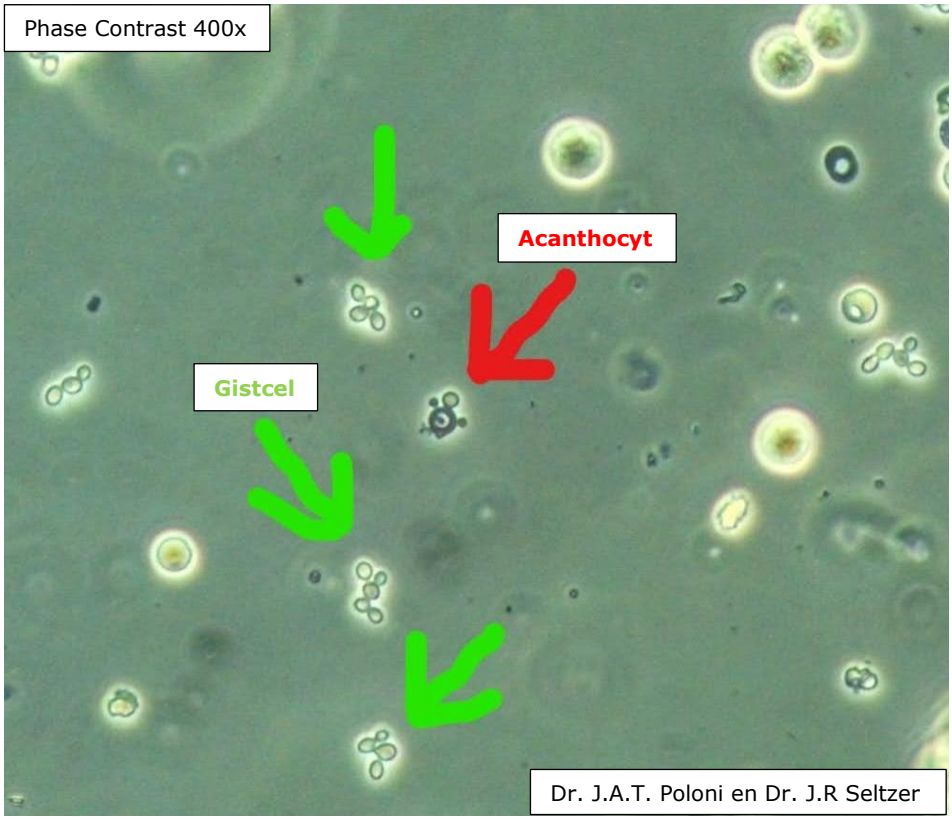
I=Isomorphic D=Dysmorphic A=Acanthocyt



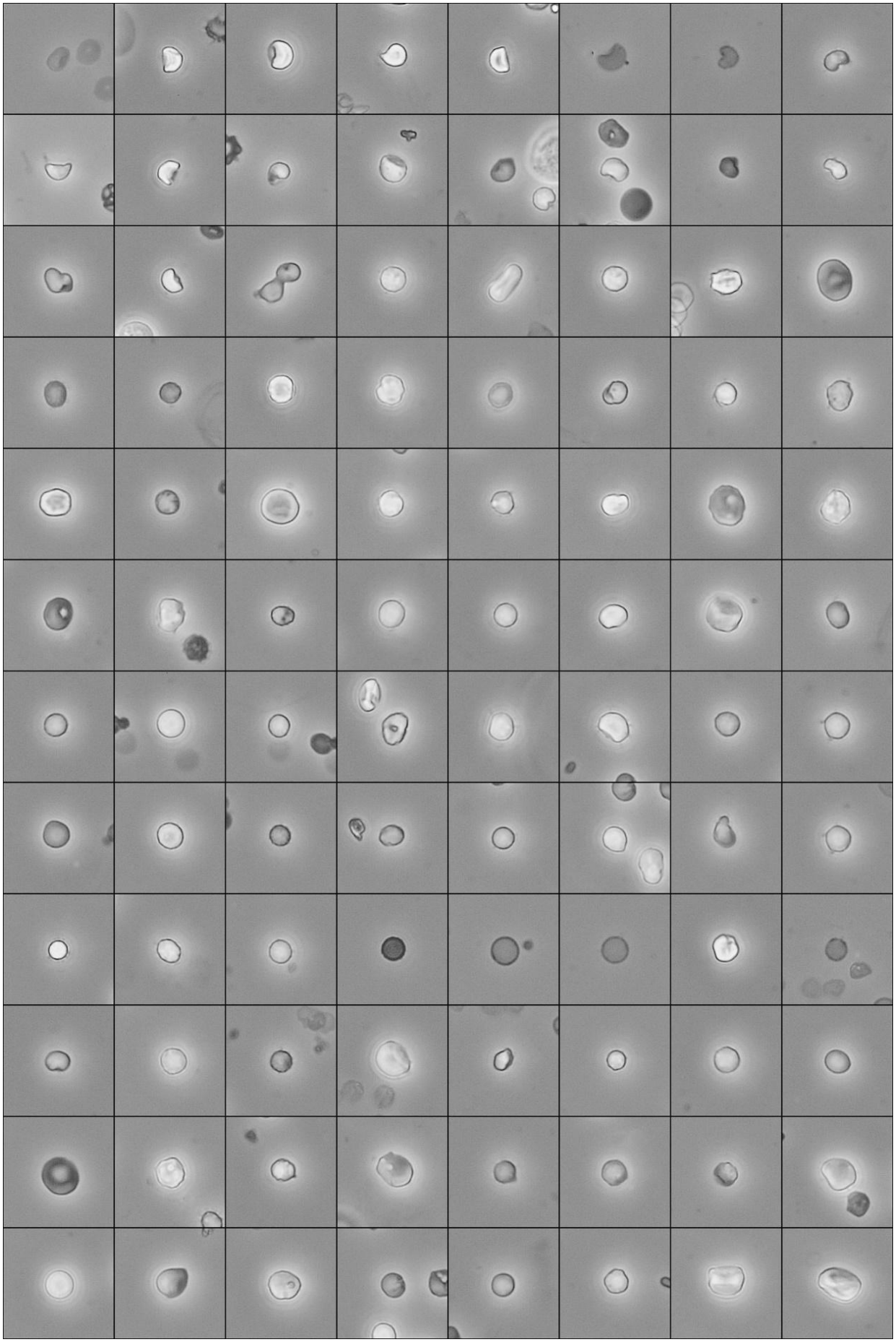


Erythrocytes: Isomorphic-Dysmorphic-Acanthocyte or Yeast Cells?





Erythrocytes Isomorphic[1]:



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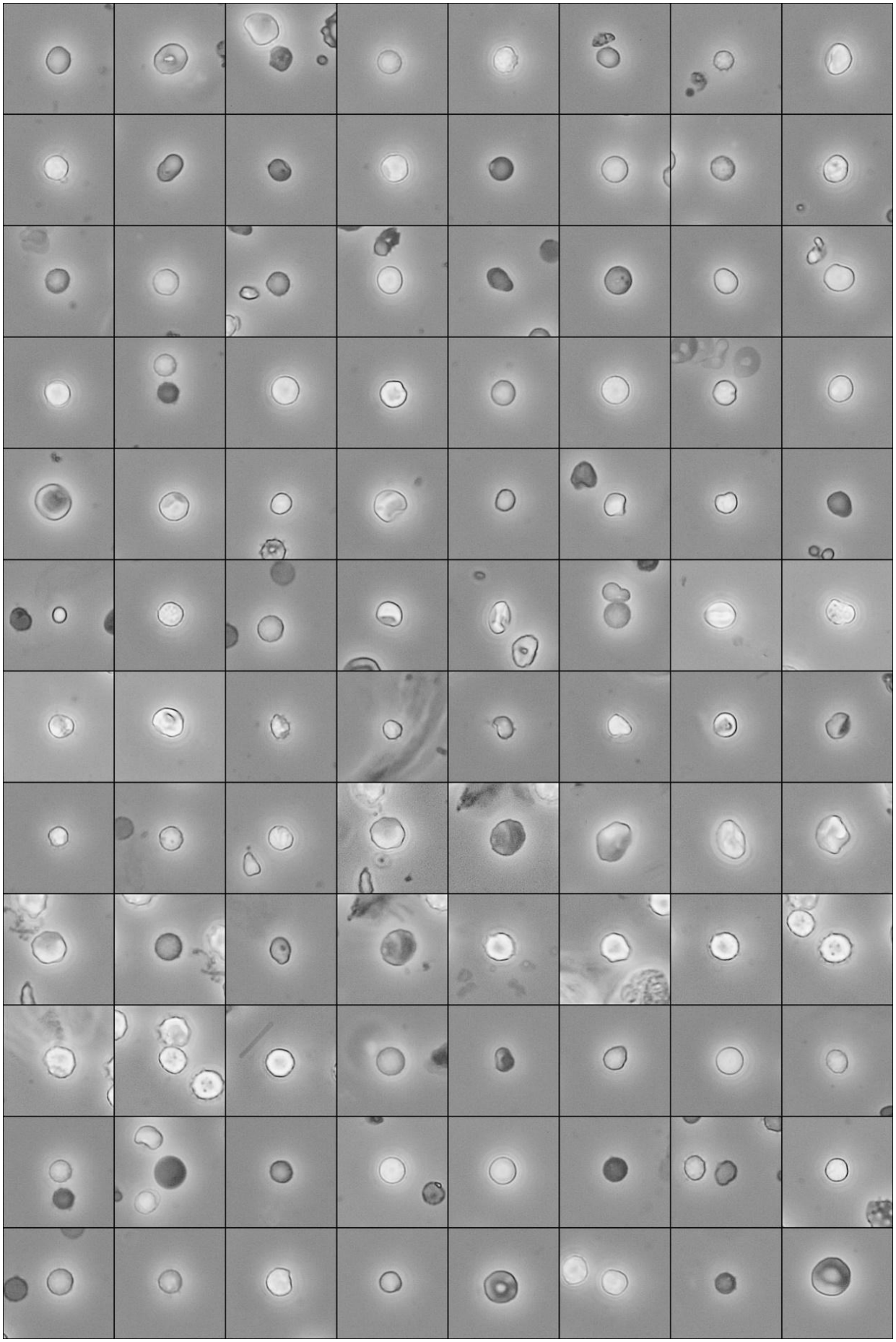

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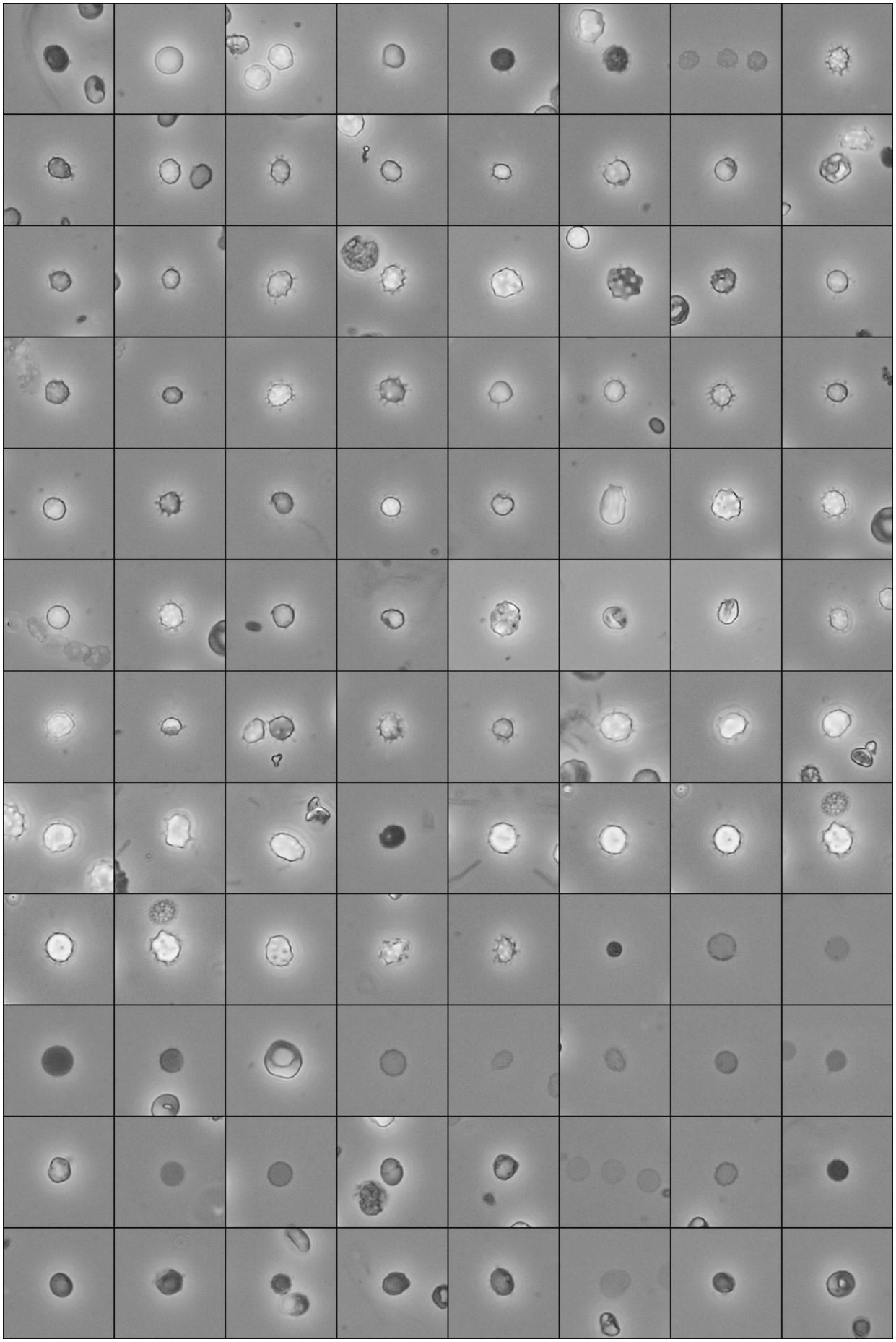

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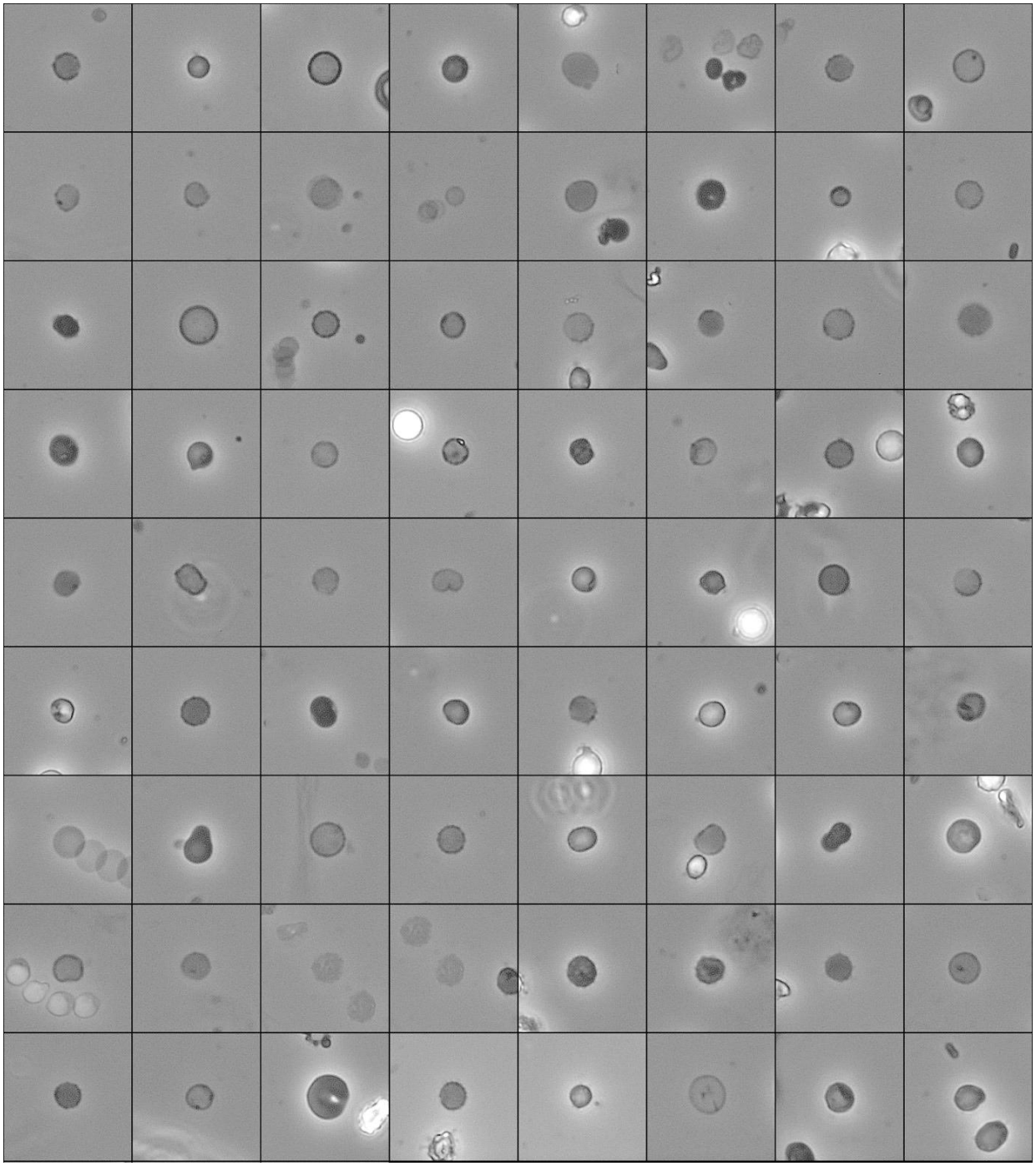
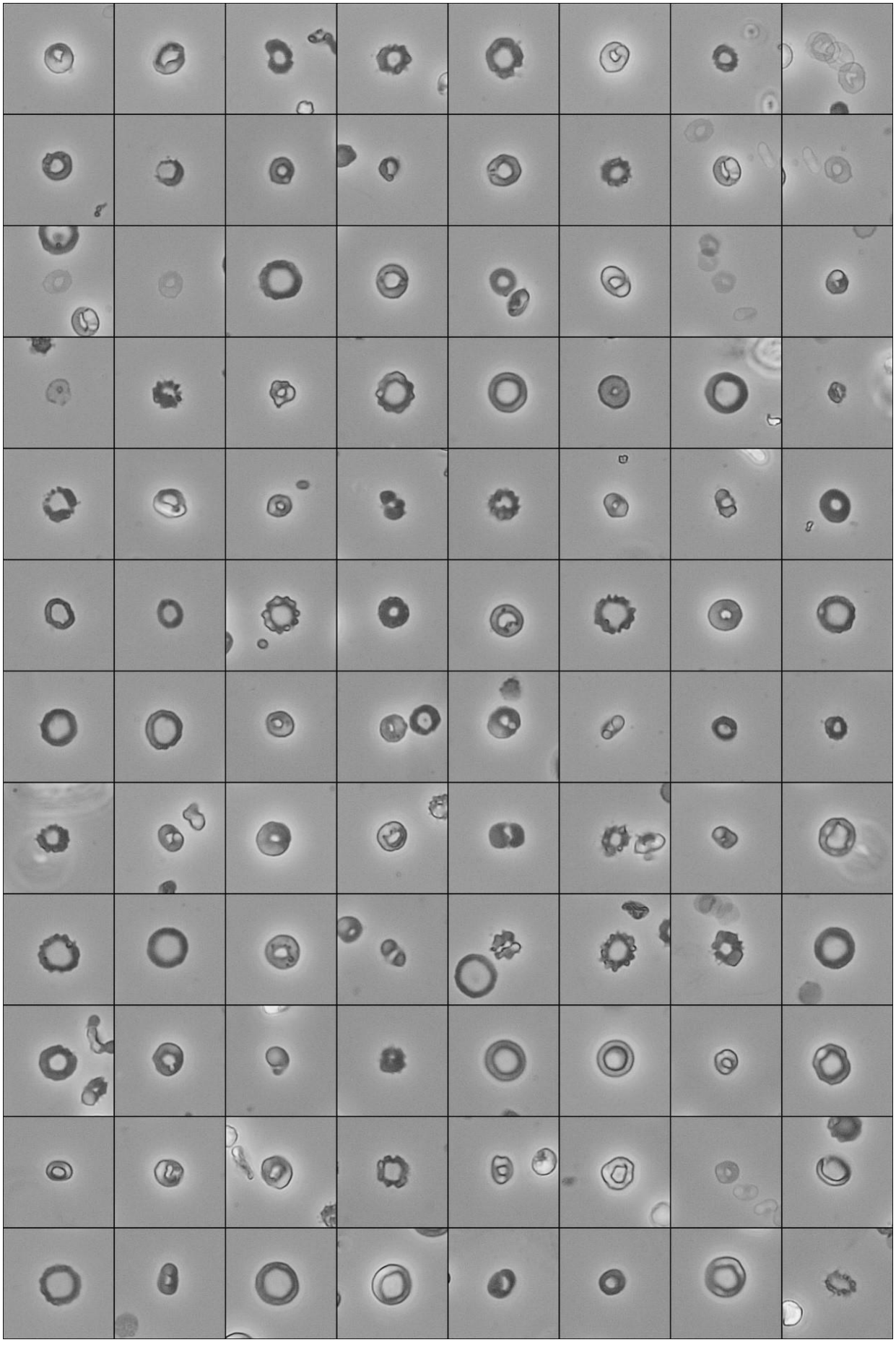


Erythrocytes Dysmorphic[1]:



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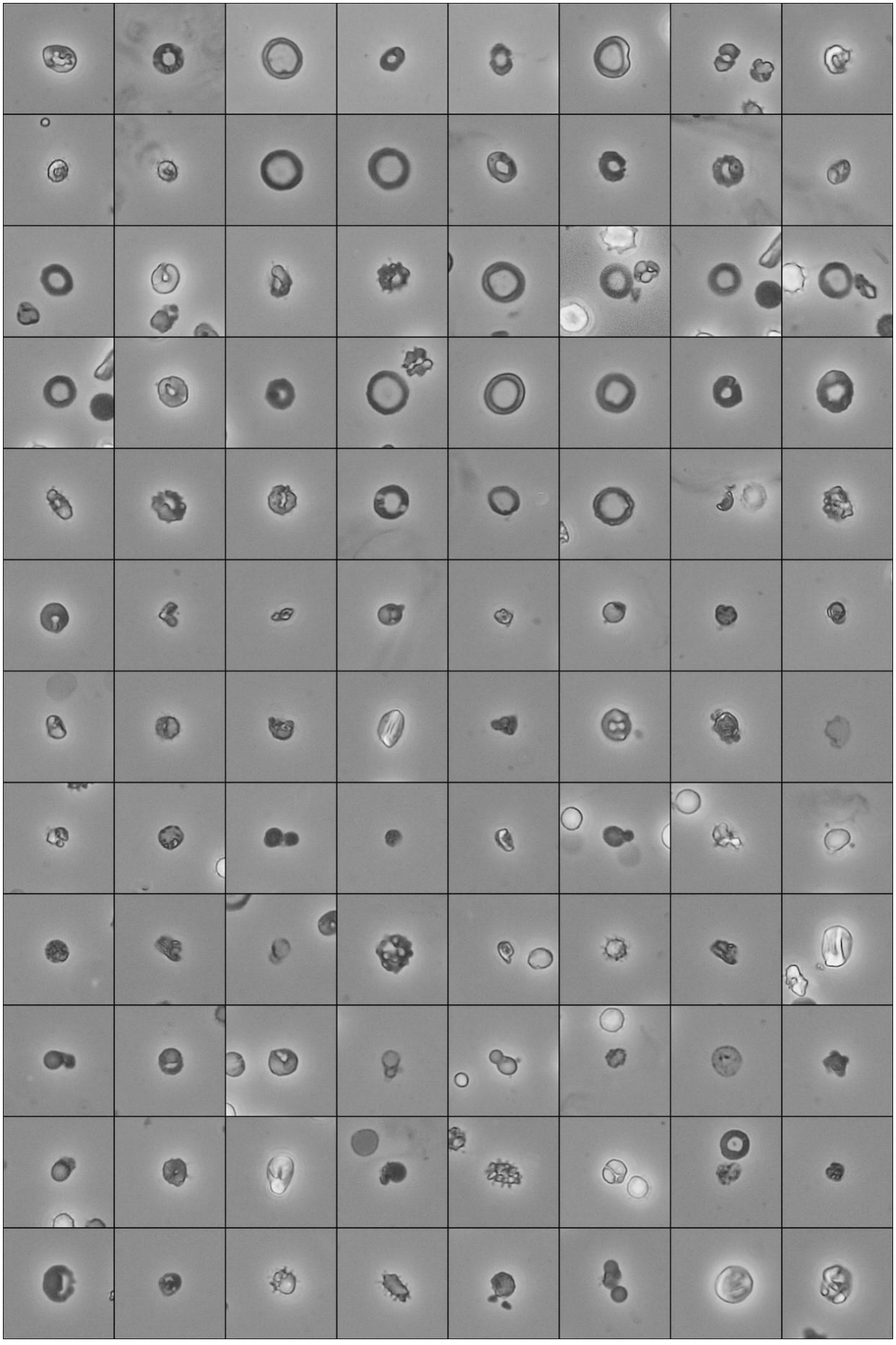

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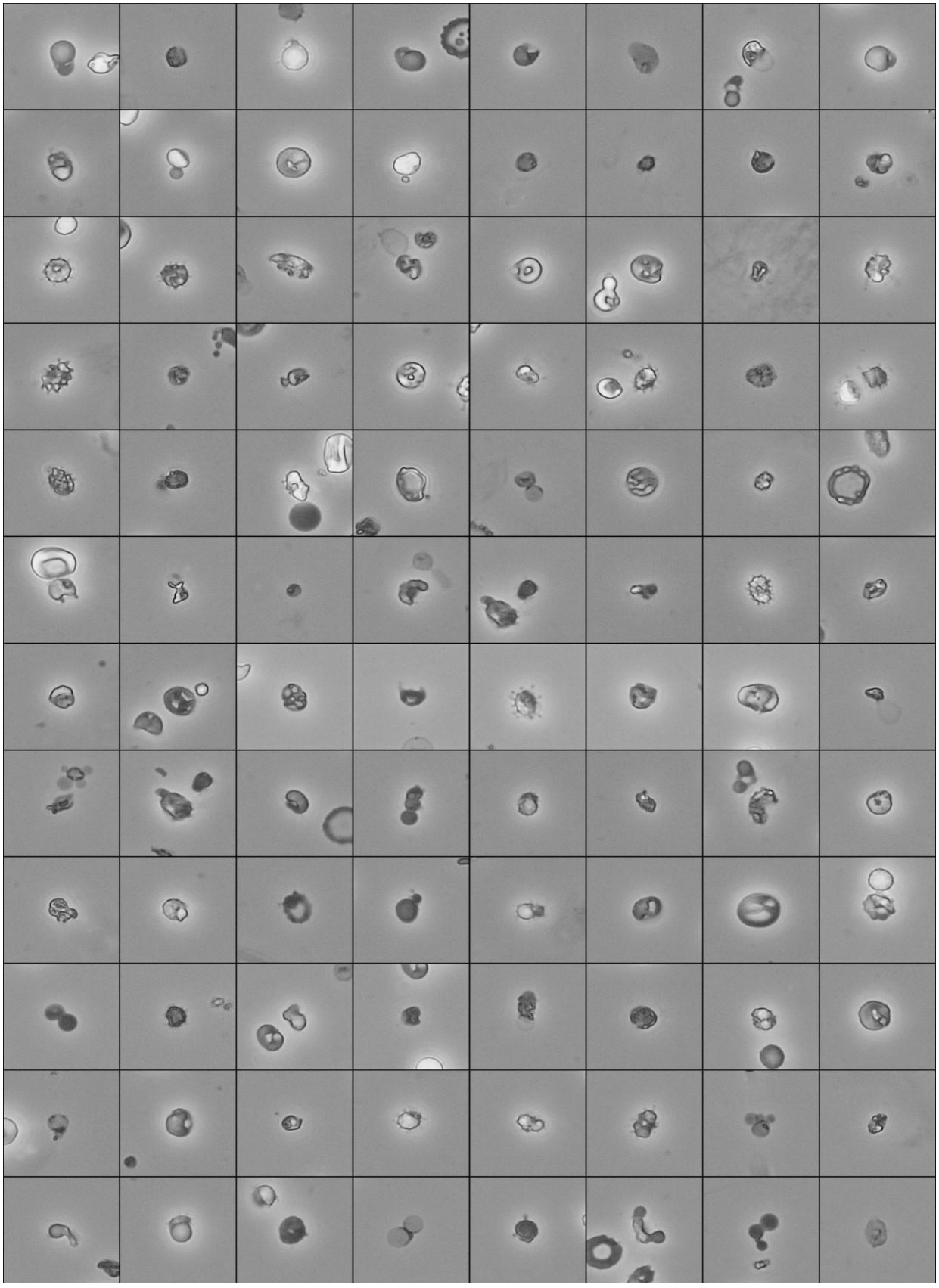

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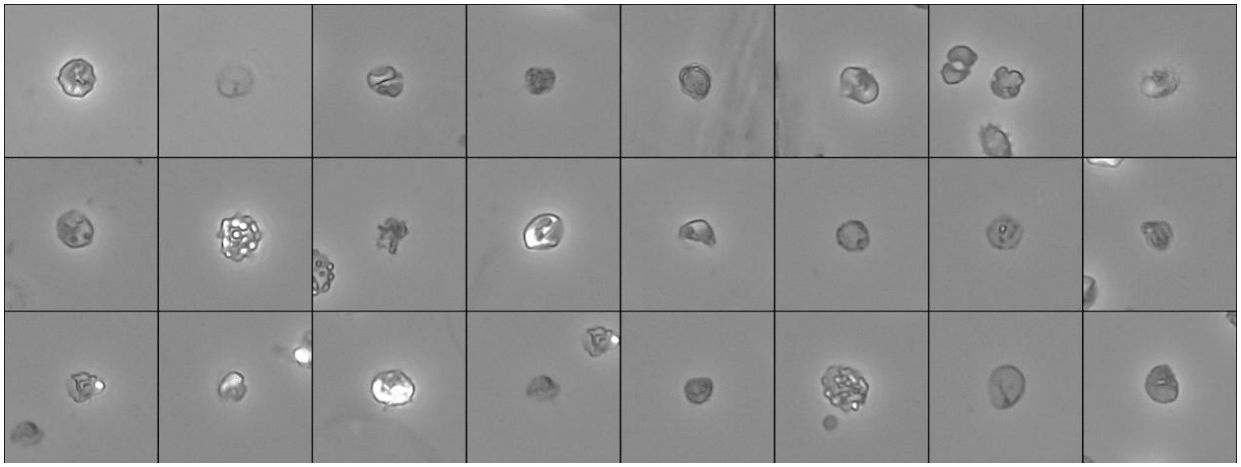
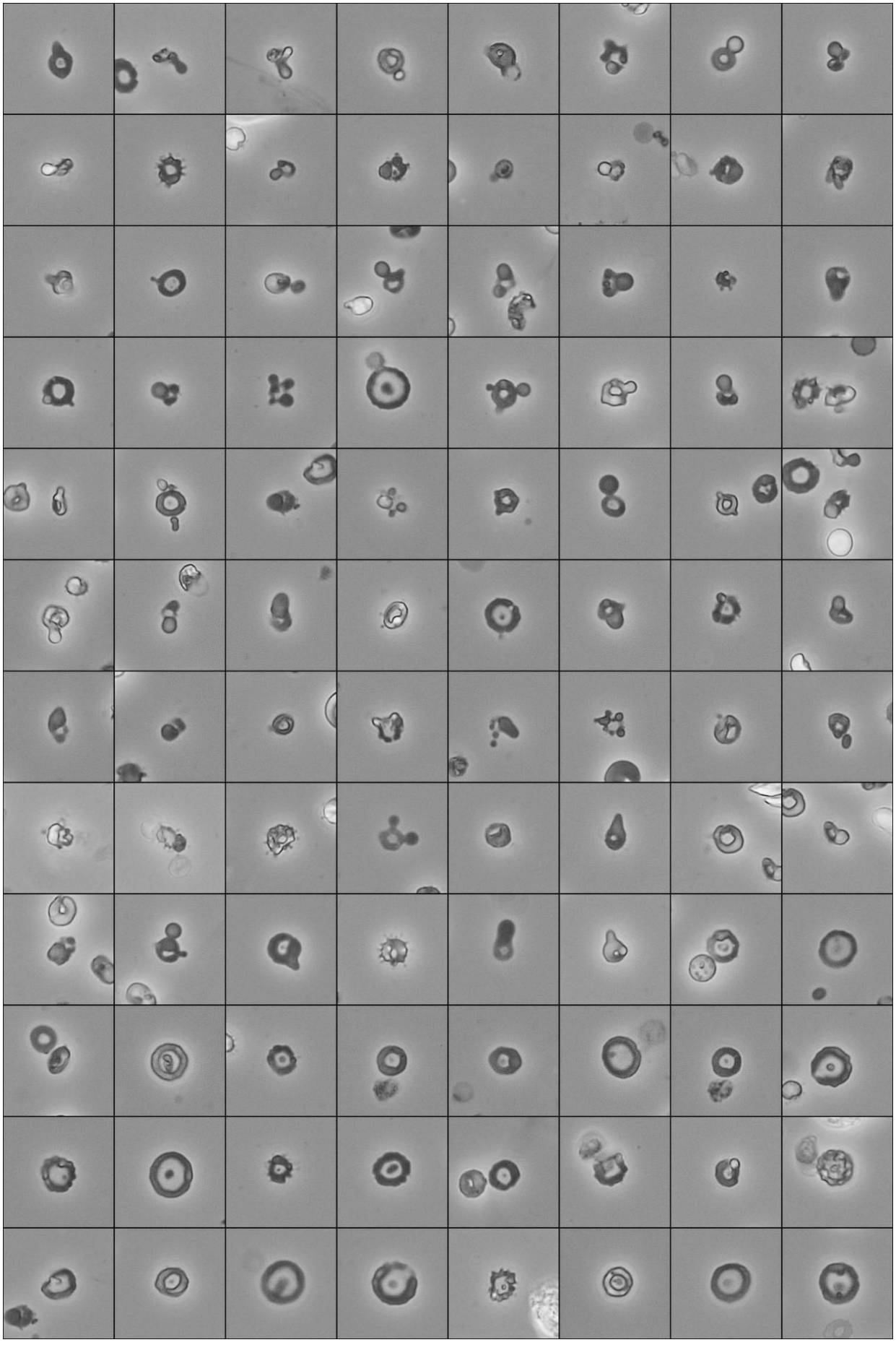
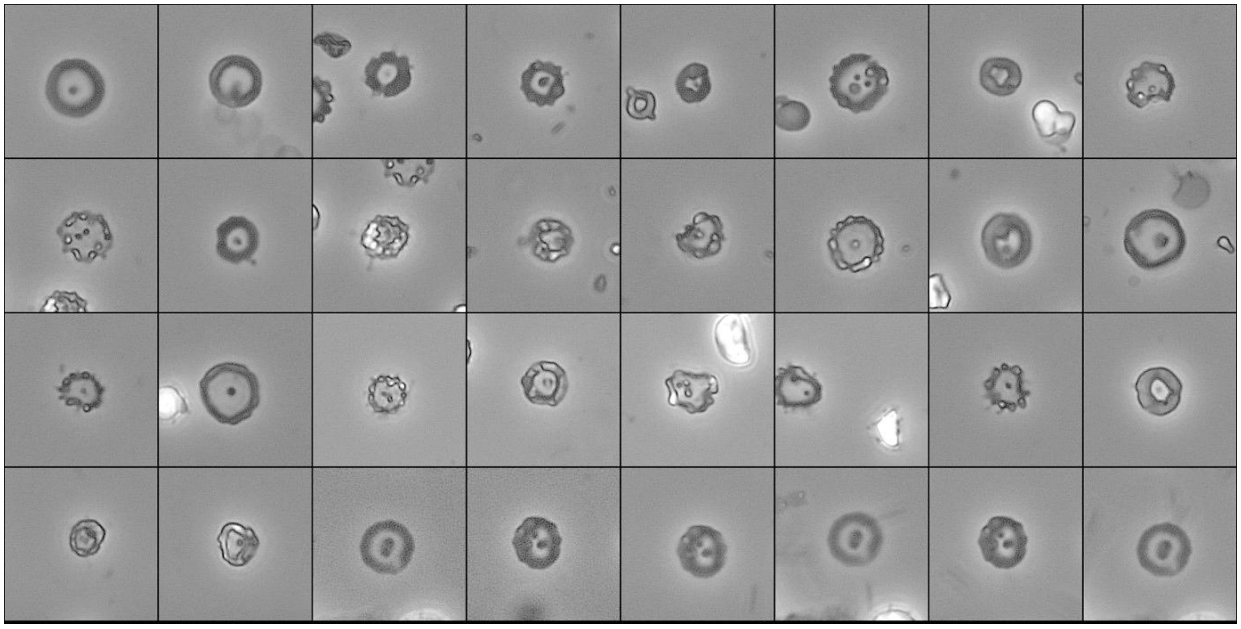


Erythrocytes Acanthocytes[1]:



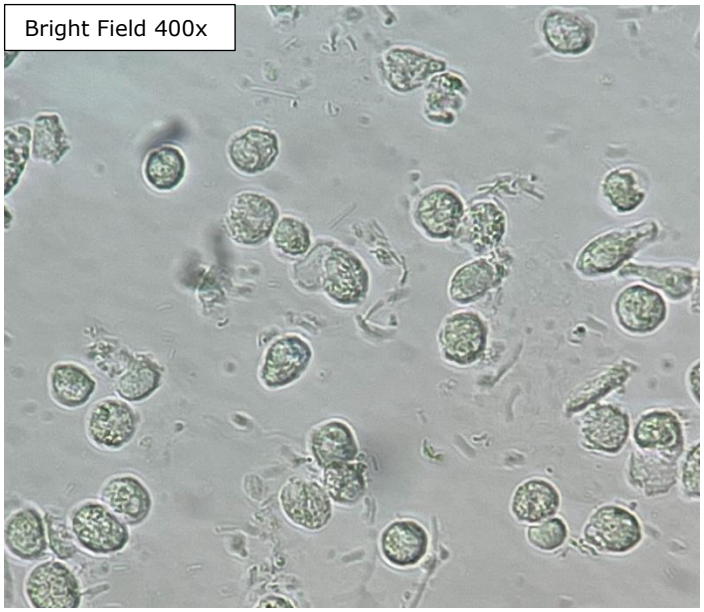
Erythrocytes Acanthocytes[1]:

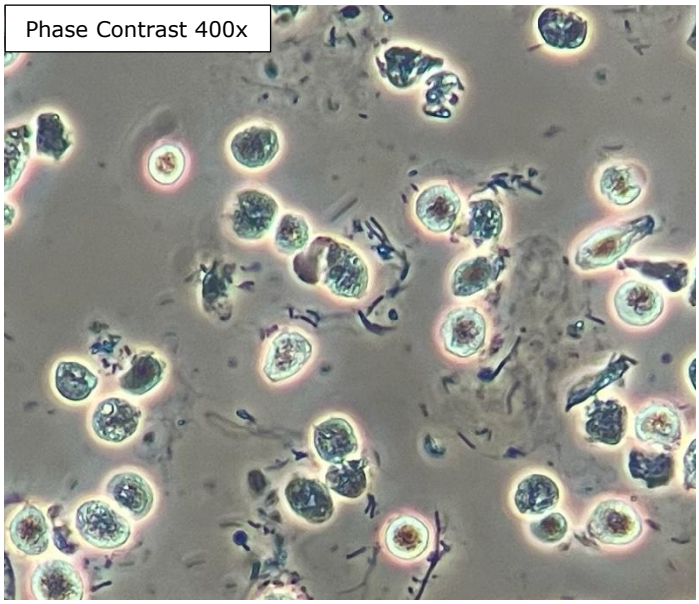


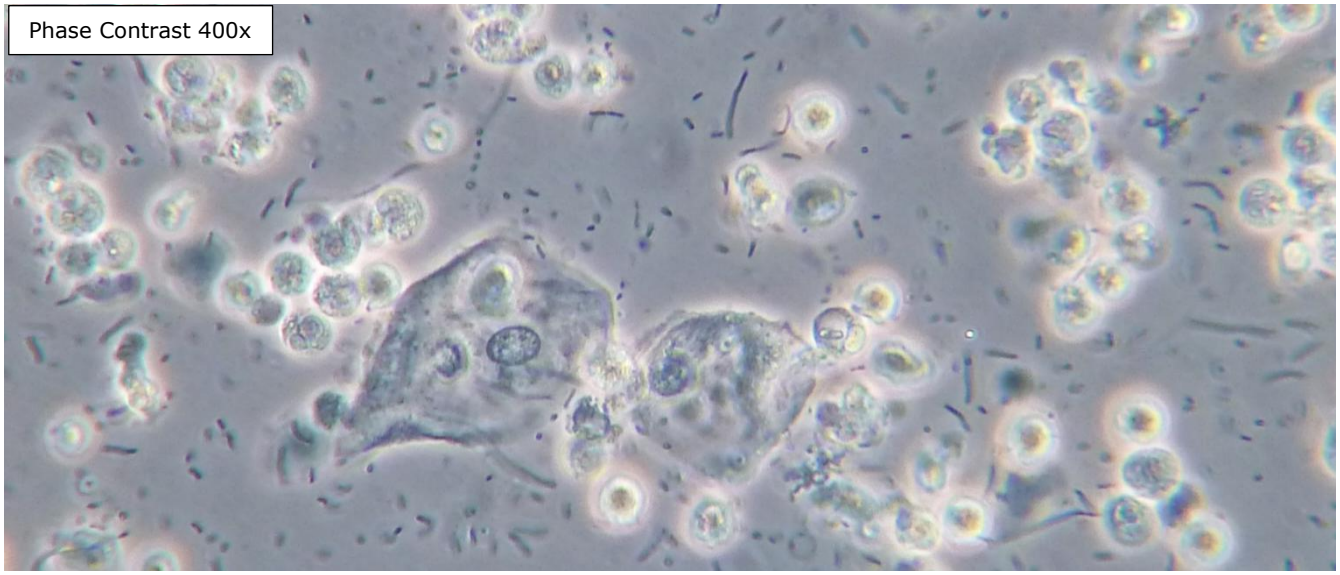
Leukocytes:

Leukocytes are round, granular, nucleated cells approximately 8-12 µm in size. All leukocytes found in blood can also be seen in urine. However, without staining, it is not possible to clearly distinguish between the different forms. If necessary, add one drop of acetic acid to the sediment to make the nuclei more visible.

Clinical significance:
- Urinary tract infection (> 20/µL or > 10 pfov, other conditions: > 2-3 pfov).
- Clusters of leukocytes often indicate an acute infection or an abscess.
- Acute cystitis (bladder infection).
- Chronic prostatitis.
- Allergic interstitial nephritis, usually caused by an allergic reaction to medications, with increased eosinophil count (> 30%).
- "Glitter cells" – large leukocytes with motility of cytoplasmic granules, often in hypotonic urine – indicate an upper urinary tract infection (pyelonephritis).
- Leukocyturia in urinary tract infections is usually accompanied by bacteriuria.
- Leukocyturia without bacteriuria is seen in kidney stones, bladder tumors, and papillary necrosis (diabetes mellitus, sickle cell anemia, tuberculosis, polycystic kidney disease).
- Temporary increases occur with fever or strenuous exercise.





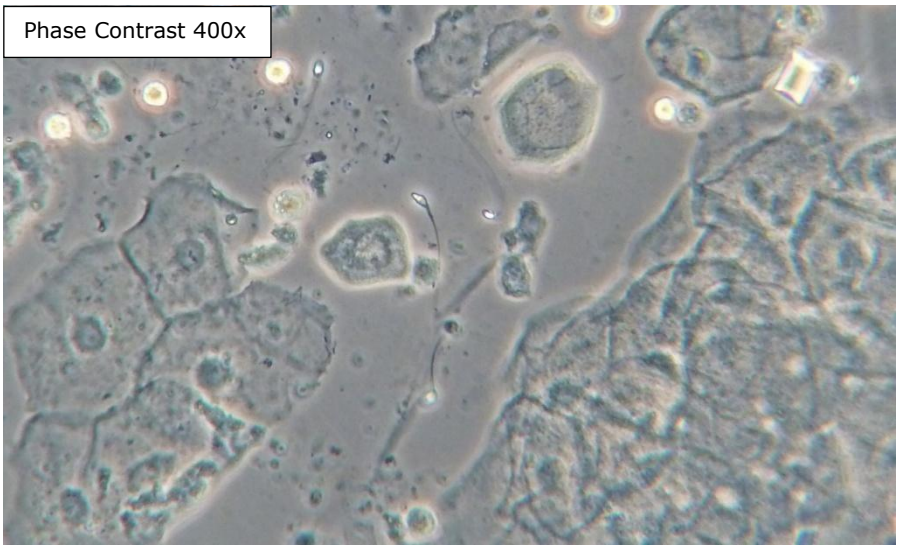


Squamous epithelial cells

These cells form the urothelium of the urethra, vulva, and reproductive tract and are approximately 20 to 100 µm in size.

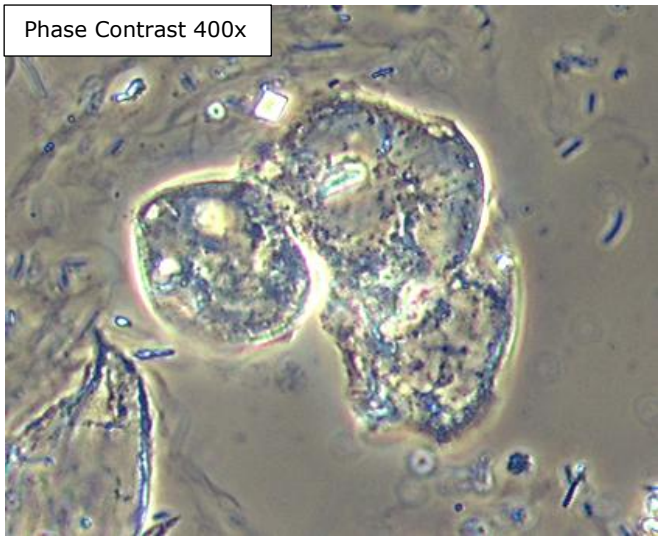
Clinical significance: - Not pathological and are primarily seen in urine not collected midstream, or in urine that has not been "washed" in pregnant women.

Phase Contrast 400x

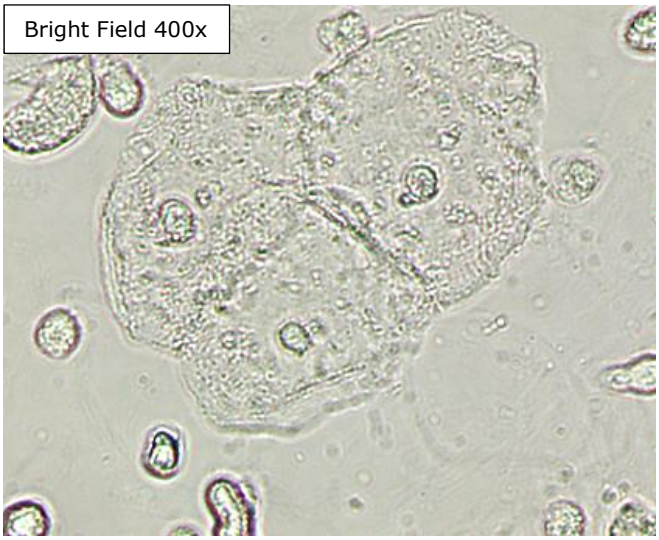


Bright Field 400x

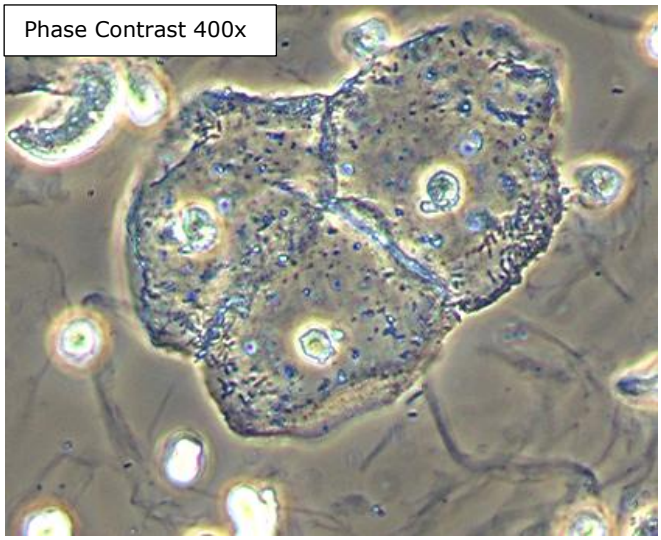
Phase Contrast 400x



Bright Field 400x



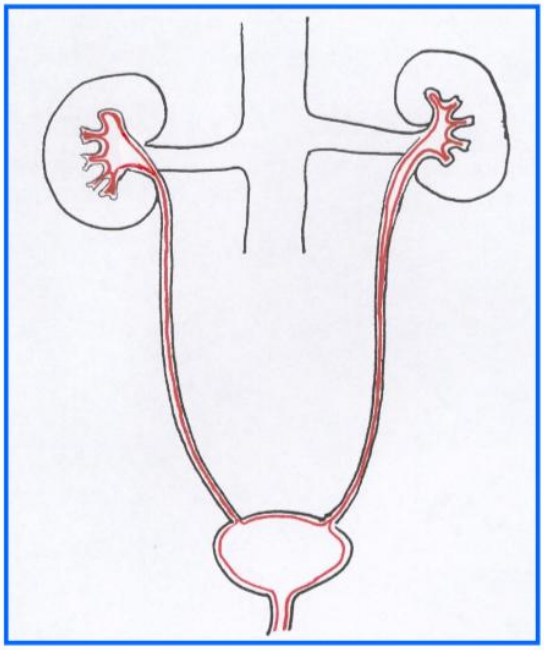
Phase Contrast 400x

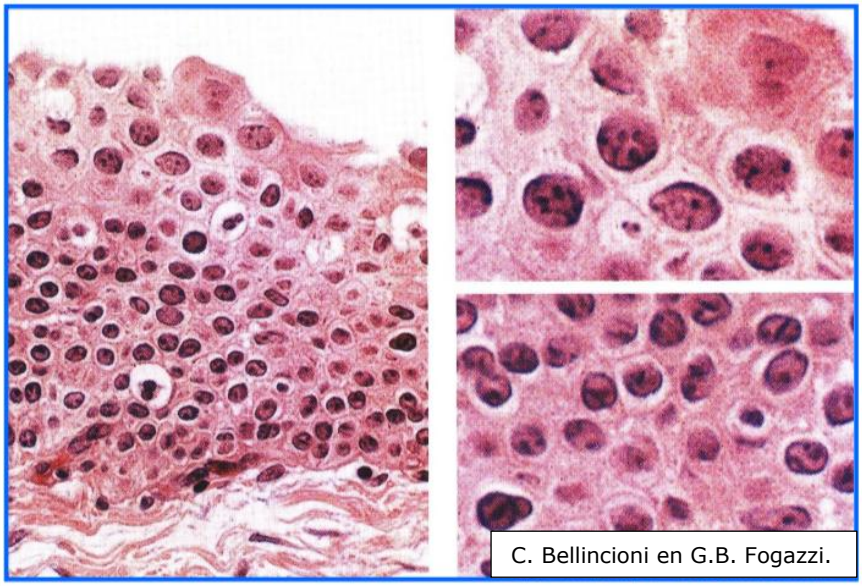


Round epithelial cells/ Transitional epithelium:

Round epithelial cells are round, granular cells with a nucleus. Their size depends on the cell's origin. If the cell originates from the upper urinary tract, it is approximately 15 µm in size and therefore difficult to distinguish from a leukocyte. If the cell originates from the lower urinary tract, it can be up to 30 µm in size. If they occur in small numbers, they are not pathological.

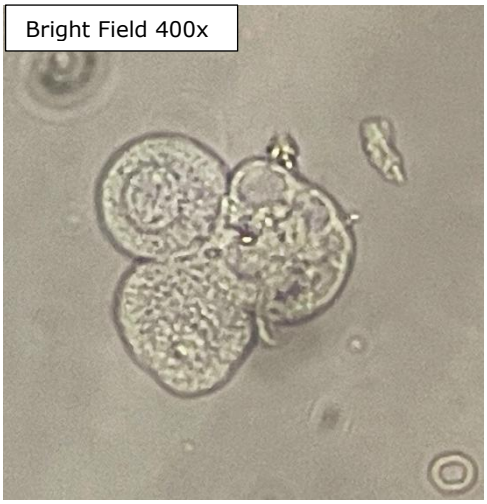
Clinical significance:
- Bladder infection.
- After urological procedures: catheter
- Due to kidney stones.
- In certain malignancies.
- In radiation therapy.
- Due to cytostatics.



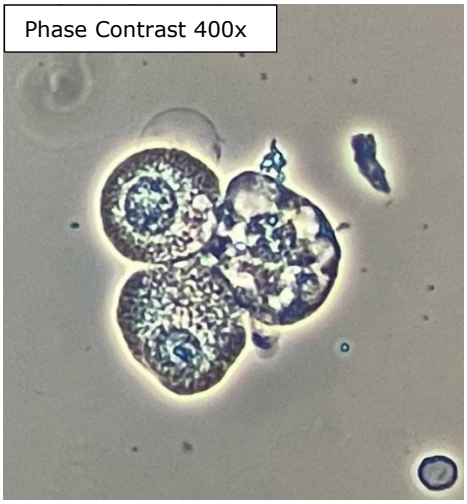


C. Bellincioni en G.B. Fogazzi.

Bright Field 400x

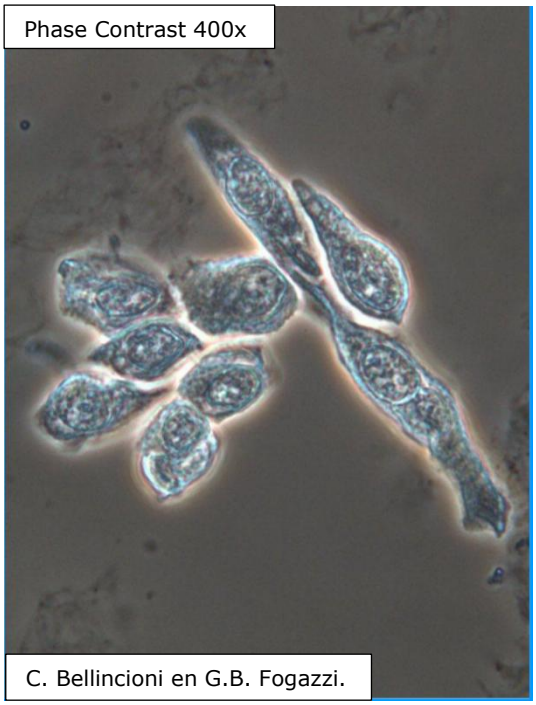


Phase Contrast 400x



Round epithelial cells/ Transitional epithelium:

Phase Contrast 400x



C. Bellincioni en G.B. Fogazzi.

PHase Contrast 400x

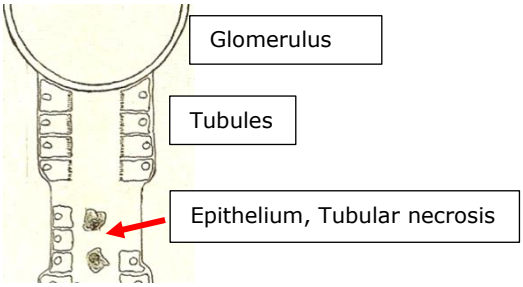
Phase Contrast 400x

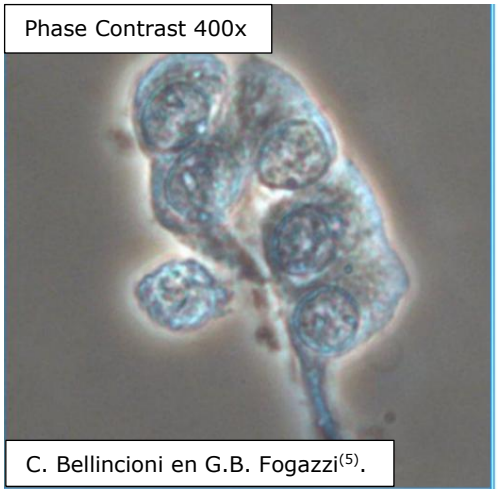
Renal Tubular Epithelial Cells (RTEC):

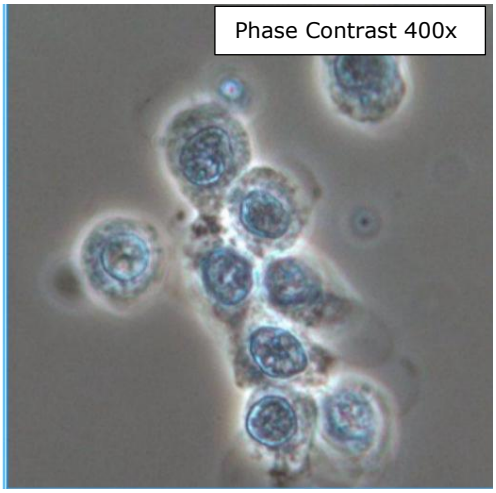
These cells form the epithelial layer of the renal tubules. The cells are 9–25 µm in size (average 14 µm) and are round, oval, rectangular, polygonal, or columnar with a large central or eccentric nucleus, sharply demarcated by granular cytoplasm, depending on the tubule's origin.

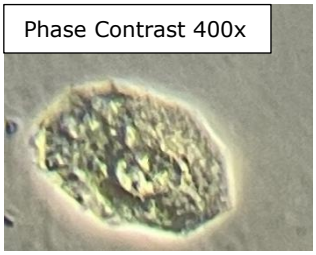
Clinical significance: Seen in cases of damage to the upper urinary tract.

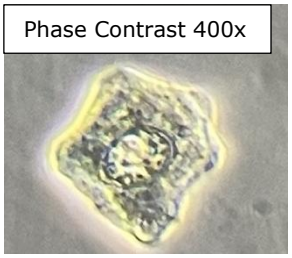
- When using certain medications: antibiotics, painkillers, anti-inflammatories, diuretics, antacids, and chemotherapy.
- Autoimmune diseases such as SLE (Systemic Lupus Erythematosus).
- Ischemia (reduced blood flow) due to shock, severe dehydration, or significant blood loss.
- Poisoning by heavy metals, poisonous mushrooms, or ethylene glycol.
- Interstitial nephritis.
- Acute rejection after kidney transplantation.
- Viral infections (Hepatitis B).
- Allergic reactions.
- Malignant infiltrations.
- In hemo- or myoglobinuria.
- Acute obstruction (kidney stones).
- Sepsis (severe infection caused by bacteria, viruses, fungi, or parasites).

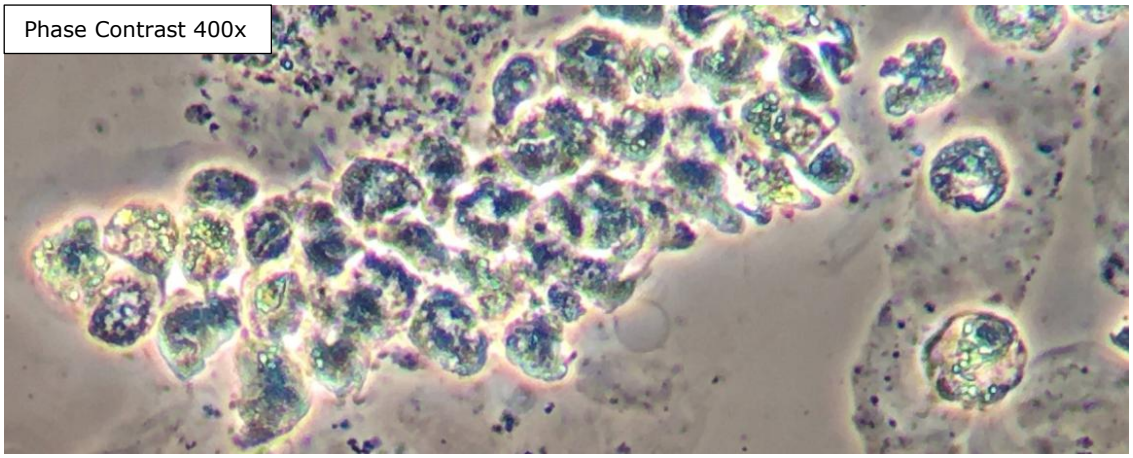










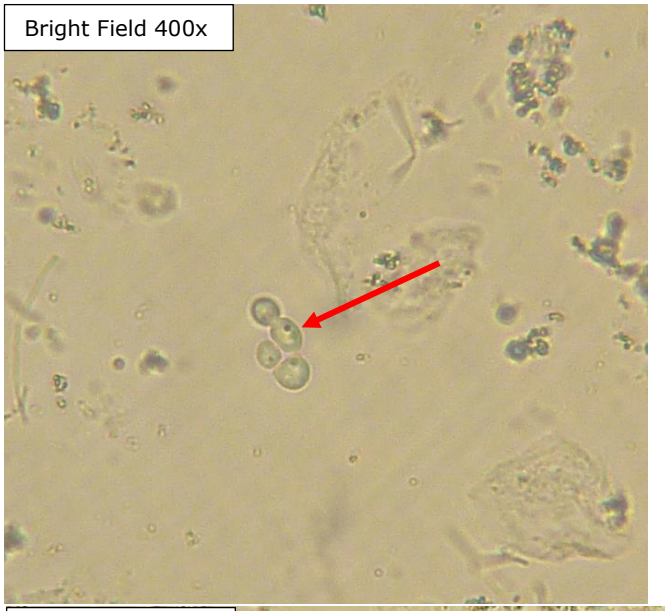


Yeast/Fungi:

Yeast cells can easily be mistaken for red blood cells in urine sediment. However, yeast cells vary in size. They are colorless, somewhat oval, and lack a dell (car tire). They often exhibit bud-shaped daughter cells (sprouting). They are sometimes also visible as hyphae.

Clinical significance: May indicate a candida infection in the urinary tract.
Diabetes and women have an increased risk.

Bright Field 400x



Phase Contrast 400x

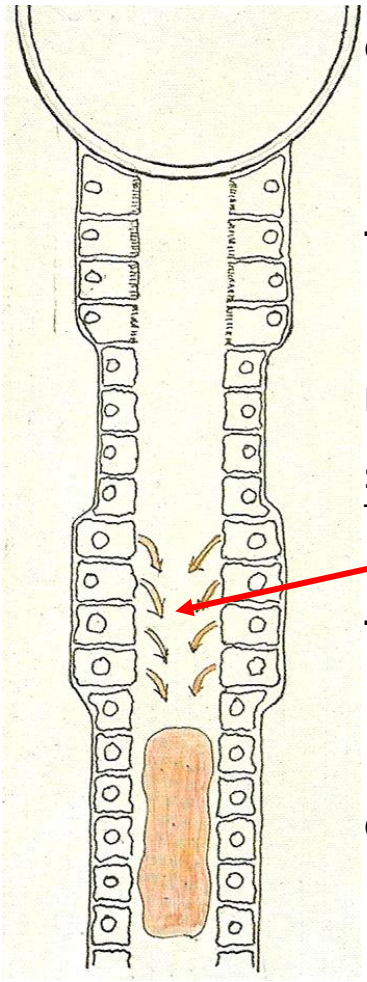
Bright Field 400x

Phase Contrast 400x

The formation of Casts:

A renal cylinder is a cylindrical cast of the renal tubule or collecting duct. Normally, urine sediment does not contain casts. However, the presence of casts does not necessarily indicate the presence of kidney disease. The formation of casts is favored by several pathophysiological conditions:

- Decreased urine output.
- Decreased blood flow.
- Increased intranephric pressure (reflux, obstruction).
- Acute cell necrosis of the glomerular membrane or destruction of the tubular wall.
- Increased salt concentration.
- Decreased pH values.
- Abnormal amounts of ions and proteins in the urine.



Glomerulus

Tubulus contortus 1

Lis of Henle

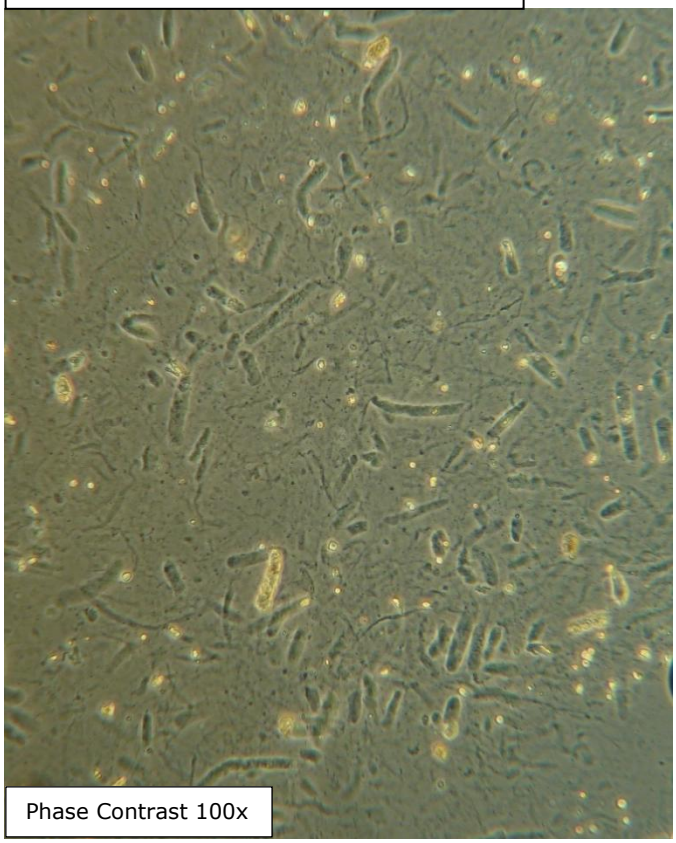
Secretion of
Tamm Horsefall protein

Protective

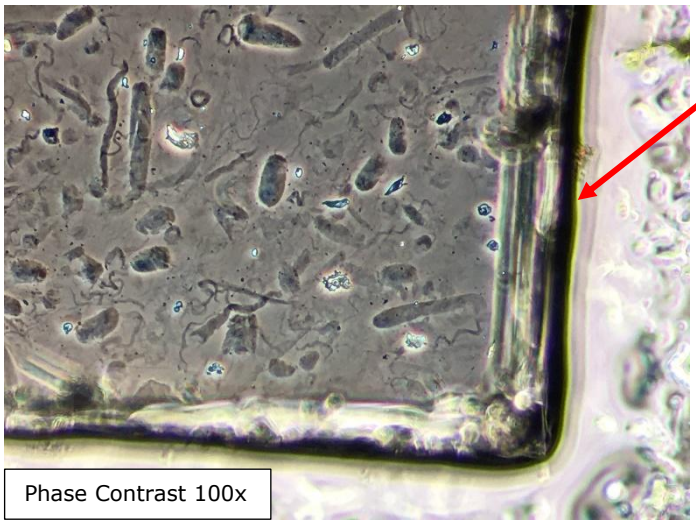
Tubulus contortus 2

Collecting tube

The basic cast: Hyaline



Phase Contrast 100x



Phase Contrast 100x

Edge of cover glass.

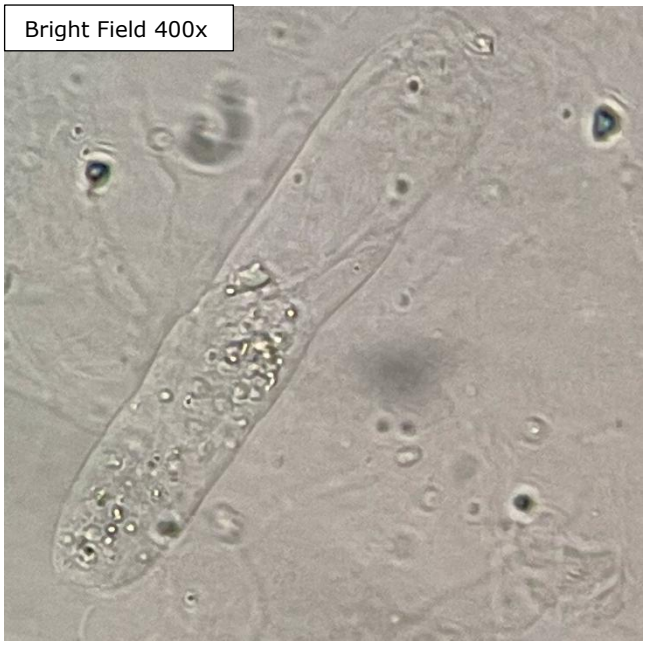
1. Start searching at the edge of the cover glass: 100x magnification phase contrast, casts focus at the edge of the cover glass.
2. Differentiate casts: 400x magnification phase contrast/bright field.
3. Evaluate the number per field of view (pfov): 100x magnification.

Hyaline casts:

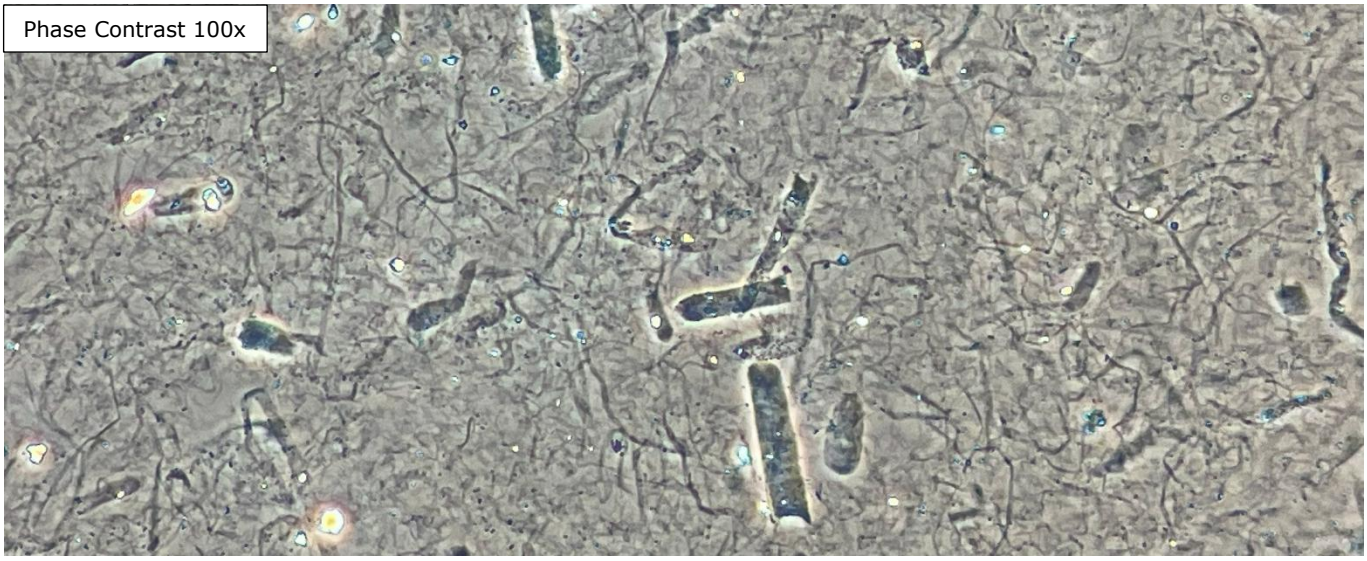
A hyaline cast consists entirely of: -Tamm-Horsfall protein (uromodulin). This mucoprotein is located in the more distal portion of the tubule and, in sufficiently acidic and concentrated urine, converts to a gel form.

Characteristics: -Transparent, colorless, homogeneous, no inclusions, varying lengths, parallel sides, rounded ends in the shapes; compact, fibrillar, convoluted, or folded.
-Difficult to identify with bright-field microscopy; refractive index differs little from their surroundings.

Clinical significance: - Normally occurs in concentrated acidic urine and disappears with prolonged standing, with bacterial contamination, and in alkaline urine.
- Sometimes higher amounts occur with:
  - the use of certain diuretics
  - fever
  - increased physical exertion
  - epileptic seizures/convulsions
  - Bence-Jones proteinuria.


Bright Field 400x


Phase Contrast 400x

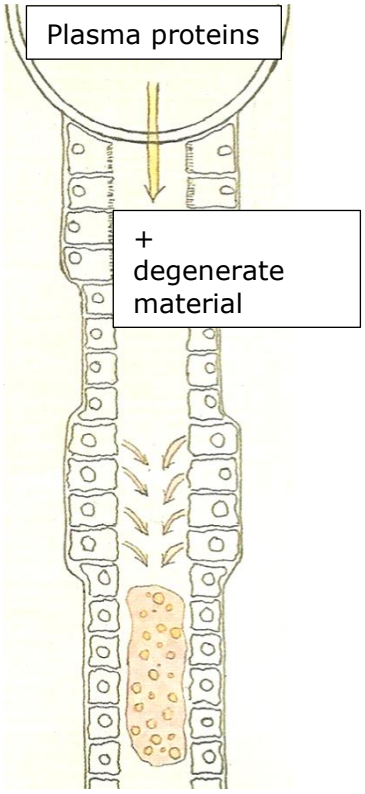

Phase Contrast 100x

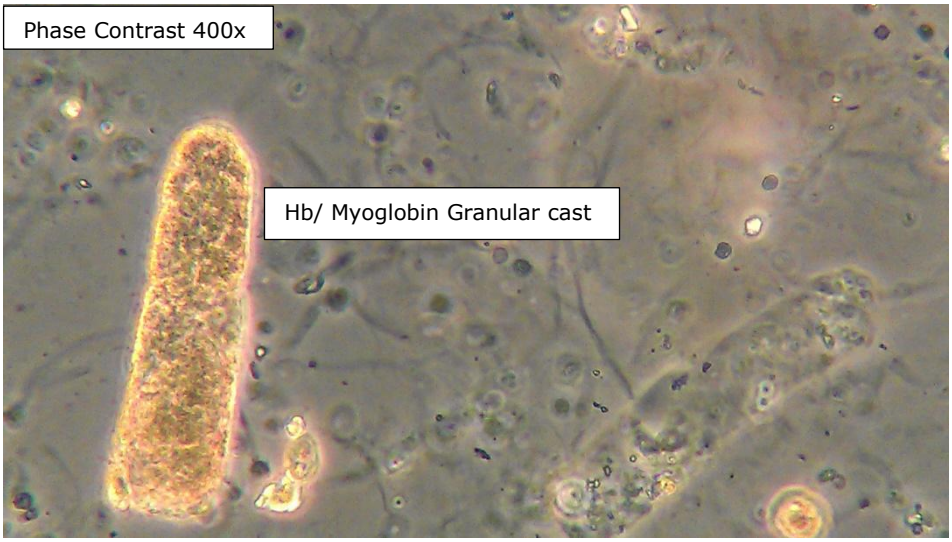
Granular casts :

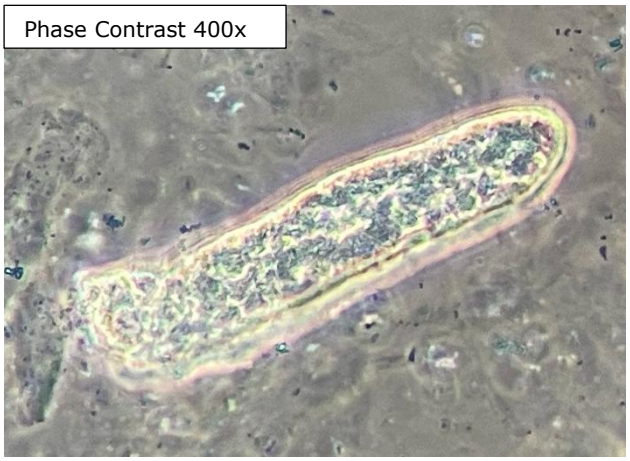
Granular casts consist of: Hyaline casts in which precipitated protein, epithelial cells, leukocytes, erythrocytes, or fat are trapped in varying proportions.

Characteristics: - Coarse-granulated, often with an admixture of cellular and granulated elements; with advanced cell breakdown, the structure becomes fine-granulated.

Clinical significance: - Granular casts are seen in glomerular and tubulointerstitial disorders.
- Highly pigmented granular casts are seen in acute tubular necrosis. (e.g., as a result of massive myocardial infarction)
- Pyelonephritis (inflammation of the kidneys)
- In small quantities in healthy individuals (after exercise and in concentrated urine).





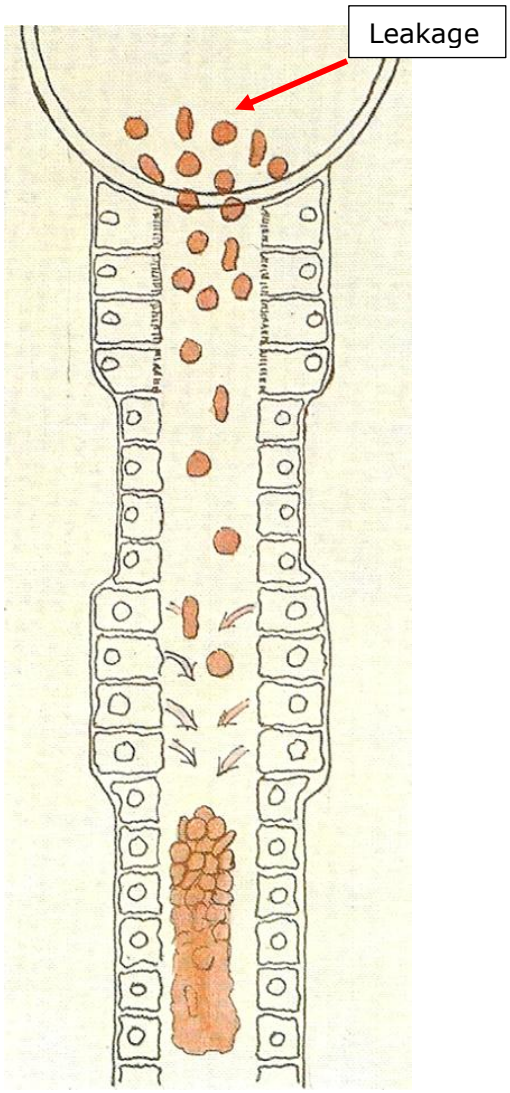


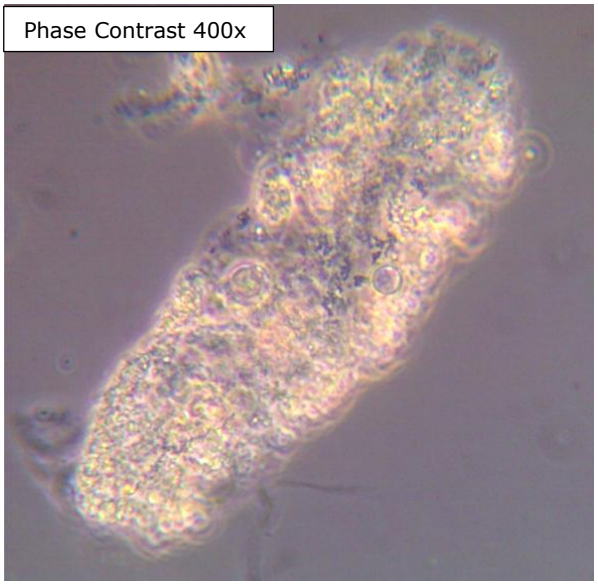
Erythrocyte casts:

Consists of: -Hyaline casts with a single or full cast containing erythrocytes.

Characteristics:
- Depending on the number of erythrocytes, the cast color varies from colorless to brown.
- Often erythrocytes lysed into granular masses of cell debris that may resemble leukocytes. The characteristic hemoglobin color remains recognizable and is called a hemoglobin cast, which cannot be distinguished from a myoglobin cast (which also has a rusty brown color).

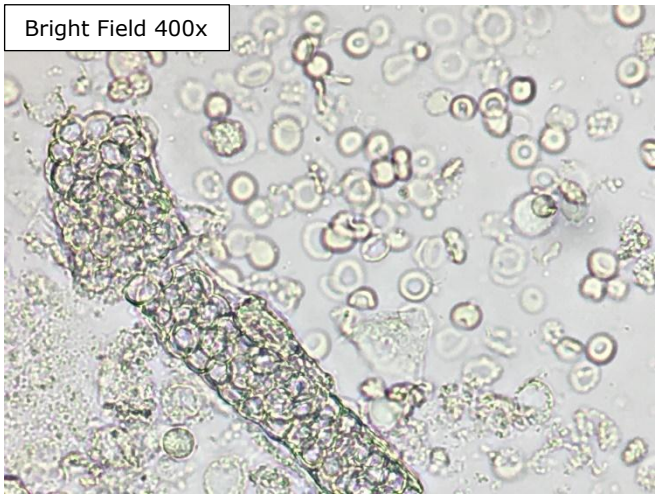
Clinical significance:
- Glomerular disorders (many abnormal erythrocytes are also seen, so-called dysmorphic erythrocytes).
- In interstitial inflammation, bacterial endocarditis, sepsis.
- After strenuous physical exertion.



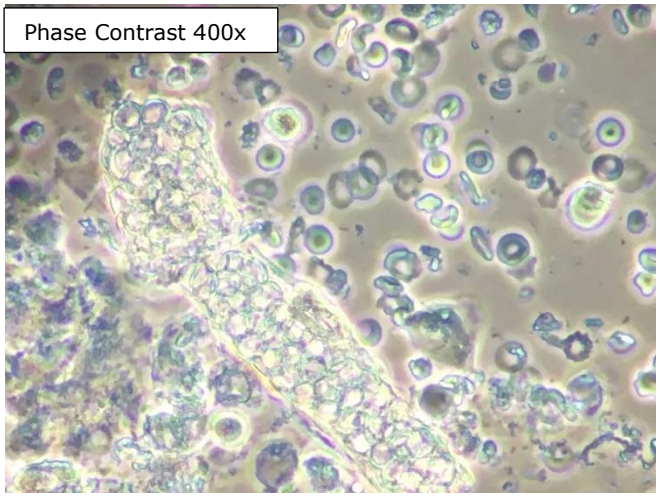


Erythrocyte casts:

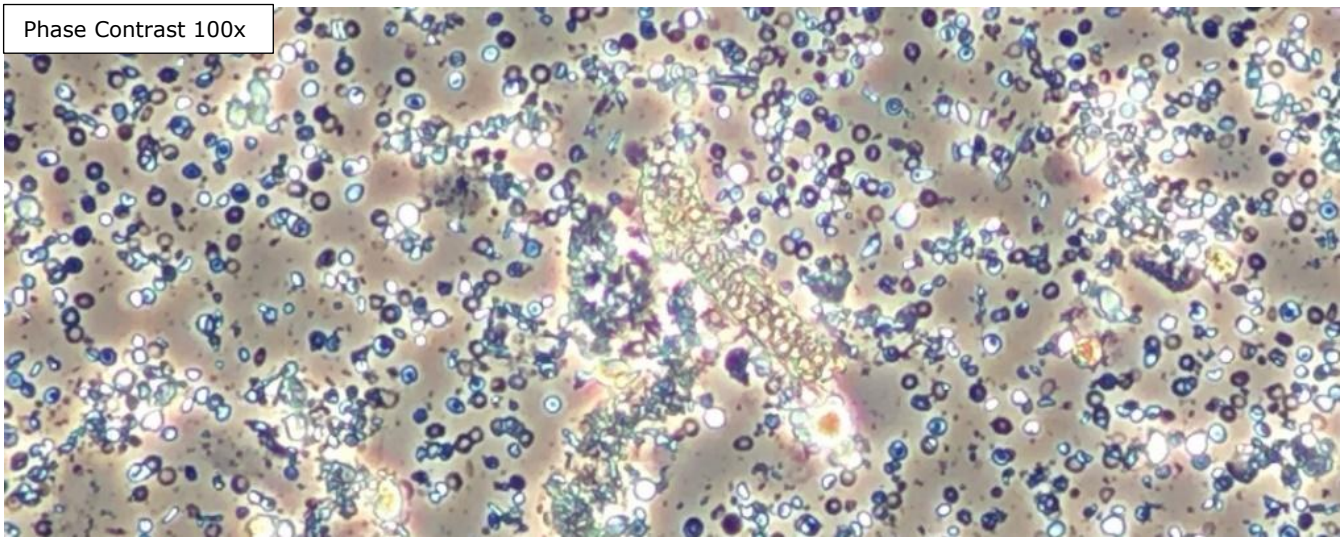
Bright Field 400x



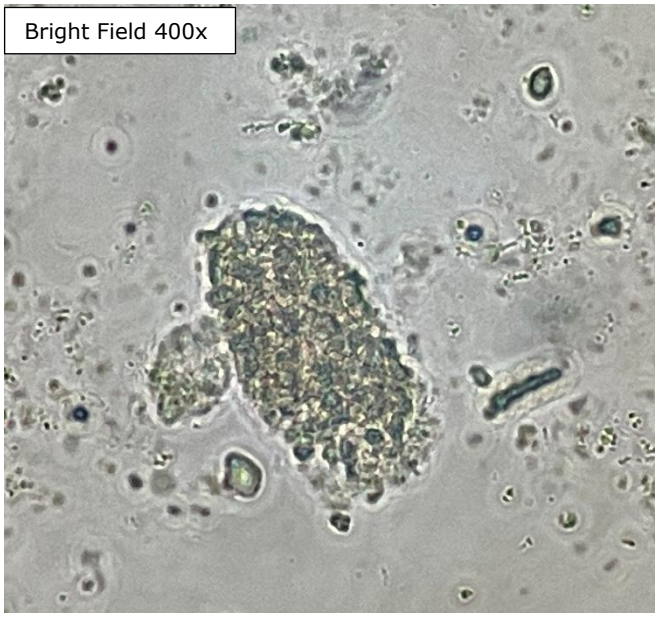
Phase Contrast 400x



Phase Contrast 100x

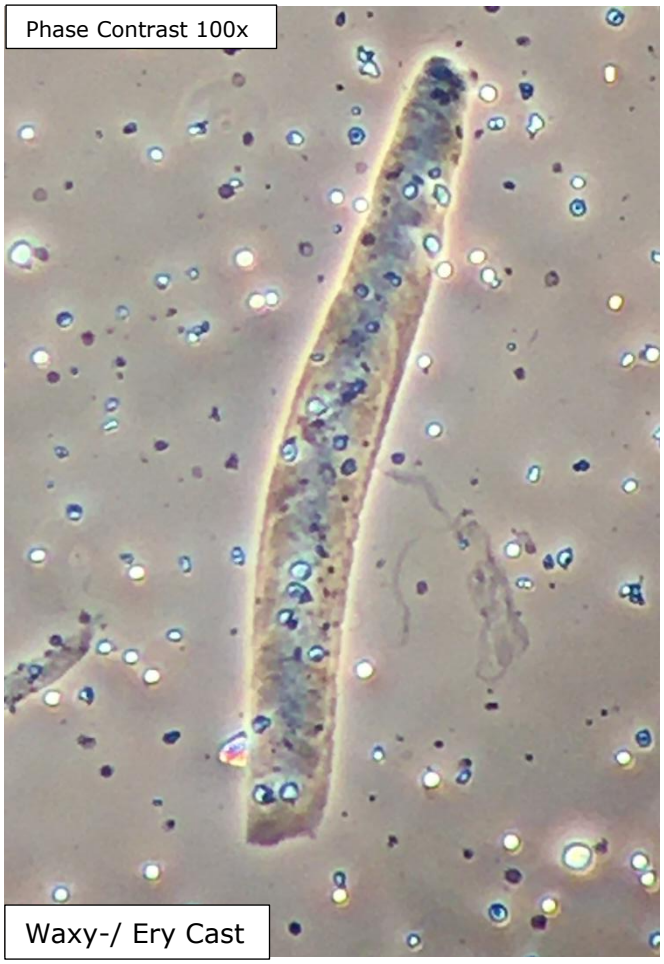


Bright Field 400x



Phase Contrast 400x

Erythrocyte casts:

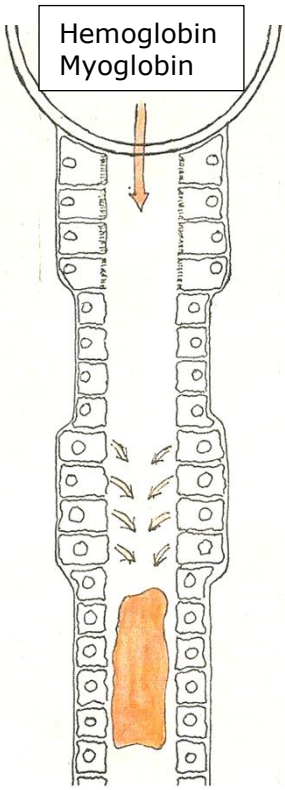


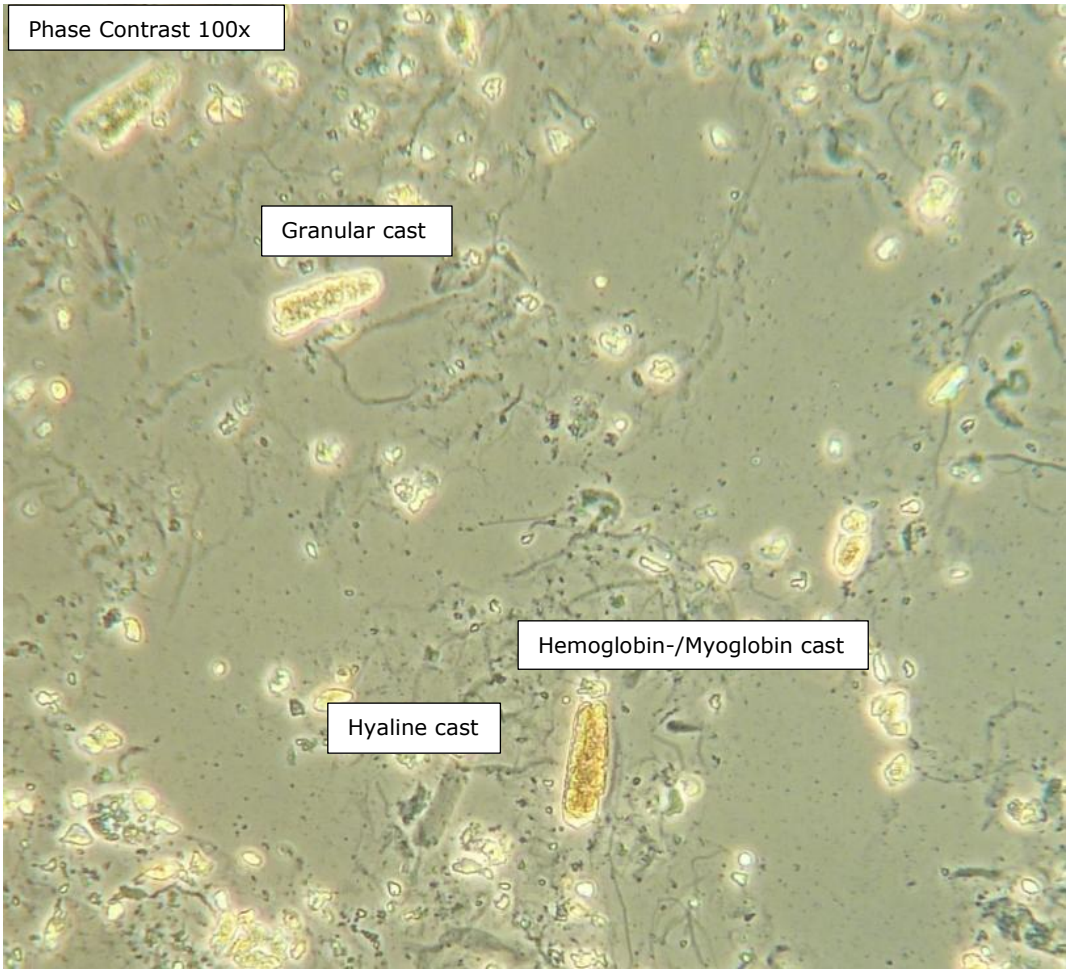
Hemoglobin/Myoglobin casts:

Consists of: -Hyaline casts filled with hemoglobin or myoglobin.

Characteristics: - Hemoglobin cylinders are indistinguishable from myoglobin casts.
- The color is dark to rust brown.
- Under the microscope, the sediment often appears mottled and flaky.
- CK, liver enzymes, and myoglobin concentrations in the blood are often elevated.

Clinical significance: - Hemoglobinuria due to intravascular hemolysis (DIC)
- Myoglobinuria due to rhabdomyolysis (massive muscle breakdown)



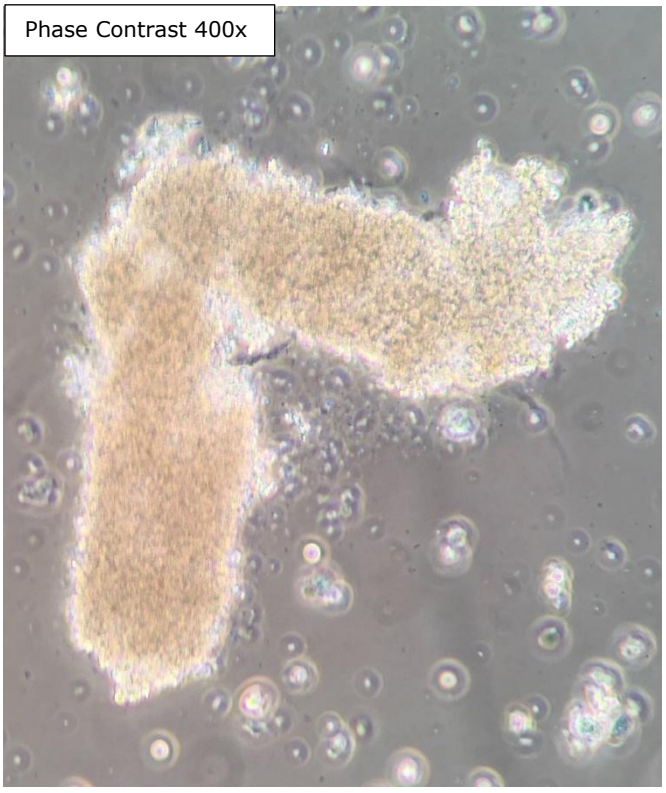


Hemoglobin/Myoglobin casts:

Phase Contrast 100x

Bright Field 400x

Phase Contrast 400x

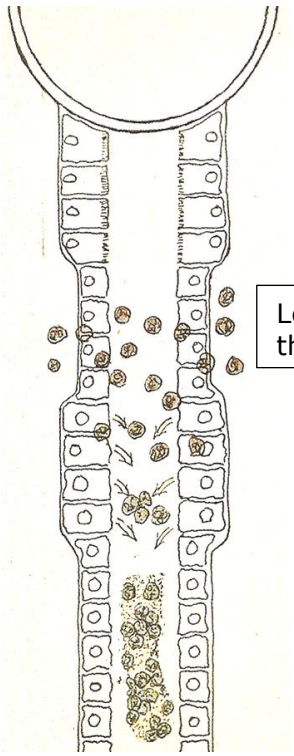


Leukocyte casts:

Consists of: - Hyaline casts, where leukocytes are held in a protein-rich environment within the tubule lumen.

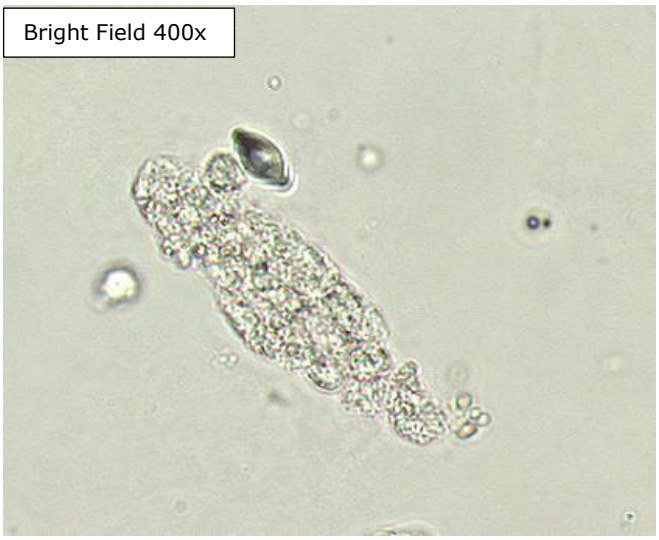
Characteristics:
- Usually consists of tightly packed leukocytes.
- Sometimes difficult to recognize if cells are degenerated.
- Sometimes pseudoleukocytes form due to the clumping of large quantities of leukocytes during centrifugation!
- Sometimes mixed forms with both leukocytes and erythrocytes or epithelial cells.

Clinical Significance: - Interstitial inflammation such as in pyelonephritis and glomerulonephritis.

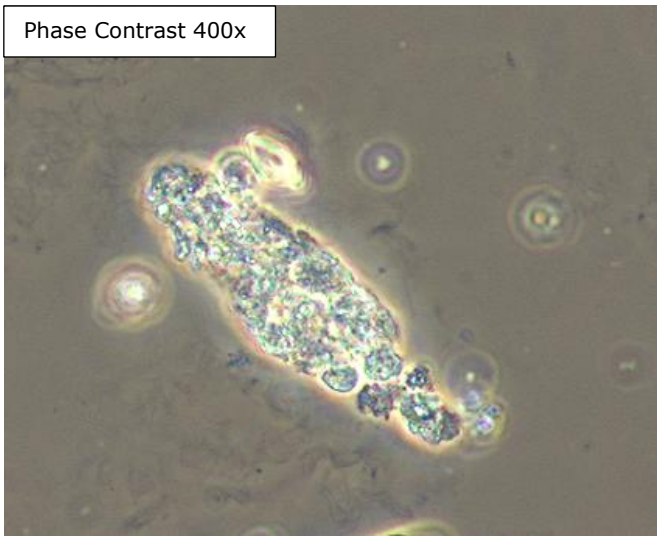


Leukocytes migrate through the cell wall.

Phase Contrast 400x



Bright Field 400x

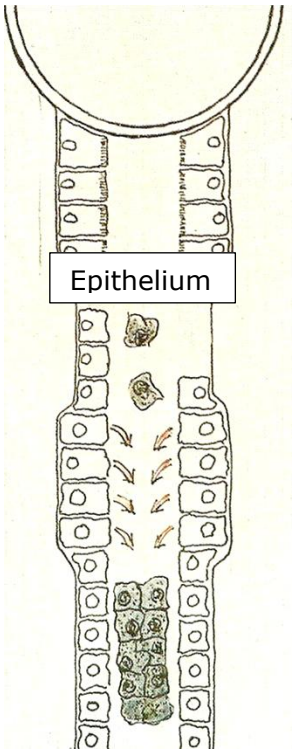


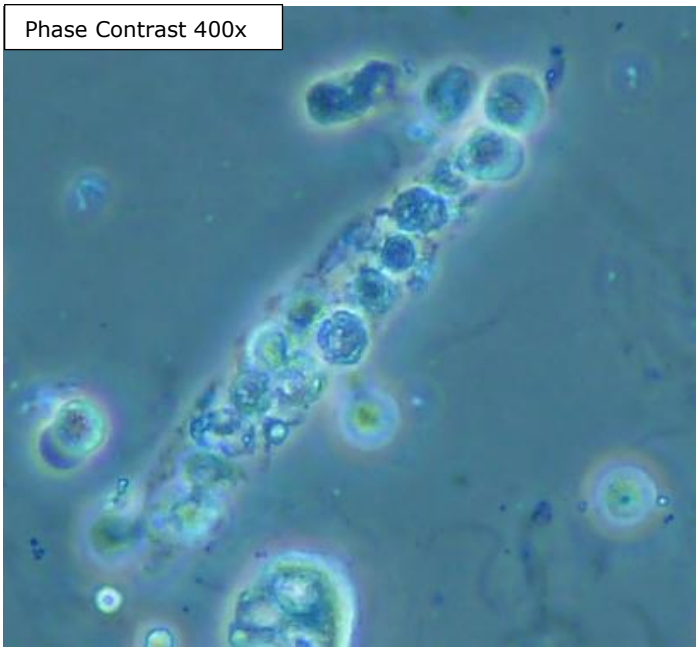
Phase Contrast 400x

Renal Tubular Epithelial Casts (RTEC's):

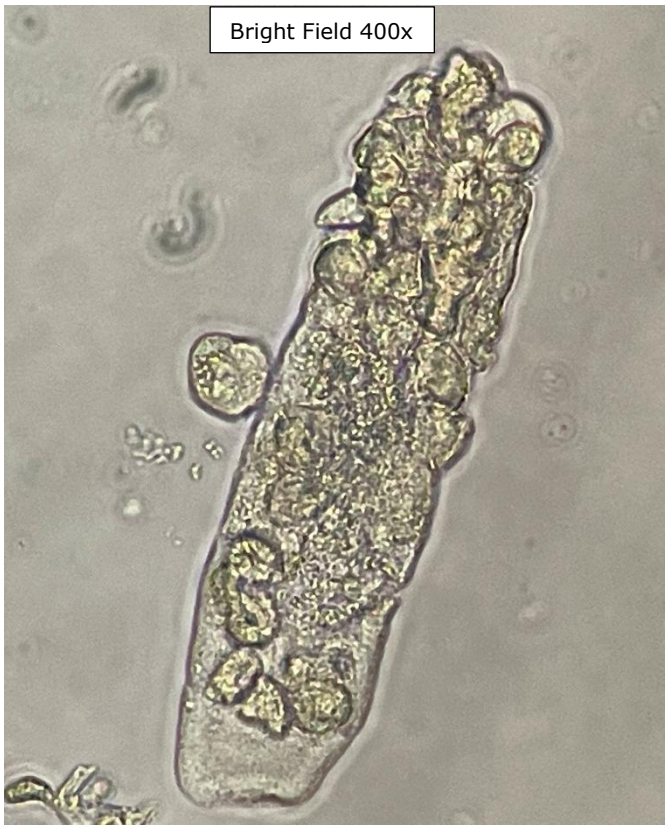
Characteristics: -Epithelial casts are often difficult to distinguish from leukocyte casts or mixed epithelial-leukocyte casts. Accurate identification is only possible if the cell contours are still intact.

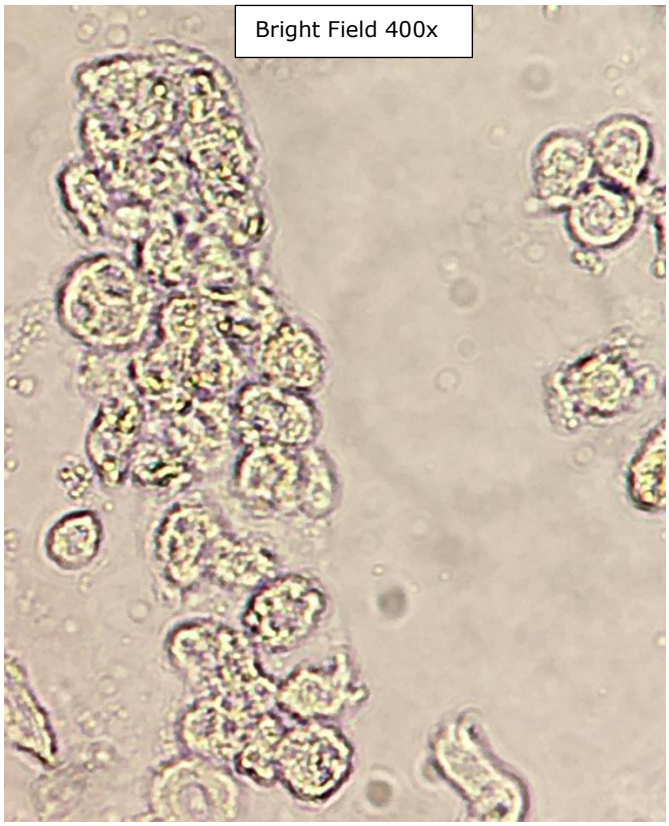
Clinical significance: Seen in cases of damage to the upper urinary tract.
- When using certain medications: antibiotics, painkillers, anti-inflammatories, diuretics, antacids, and chemotherapy.
- Autoimmune diseases such as SLE (Systemic Lupus Erythematosus).
- Ischemia (reduced blood flow) due to shock, severe dehydration, or significant blood loss.
- Poisoning by heavy metals, poisonous mushrooms, or ethylene glycol.
- Interstitial nephritis.
- Acute rejection after kidney transplantation.
- Viral infections (Hepatitis B).
- Allergic reactions.
- Malignant infiltrations.
- In hemo- or myoglobinuria.
- Acute obstruction (kidney stones).
- Sepsis (severe infection caused by bacteria, viruses, fungi, or parasites).

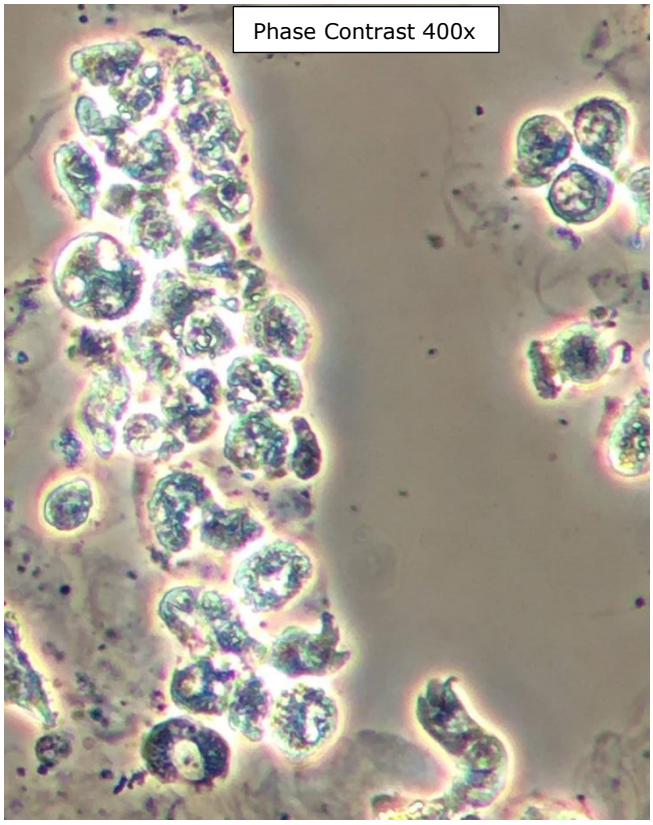




Epithelium-/Leukocyte casts:





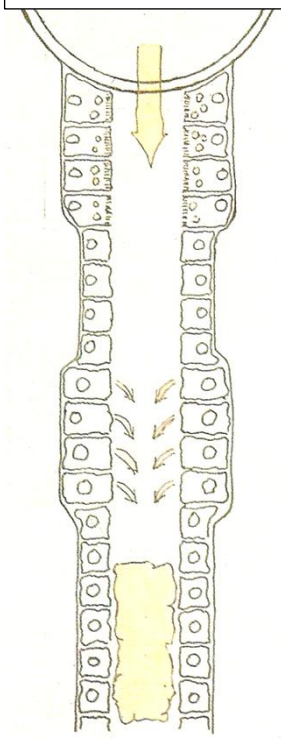


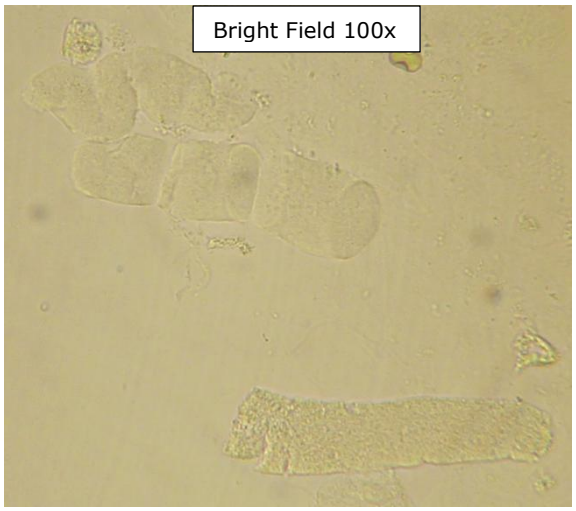
Waxy casts:

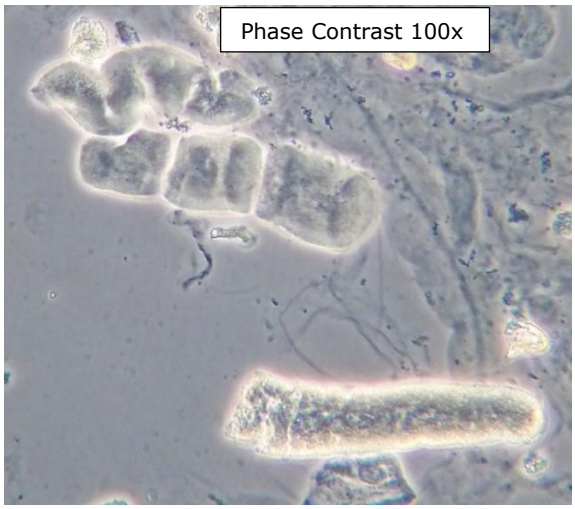
Consists of: -Hyaline casts filled with probably denatured plasma proteins.

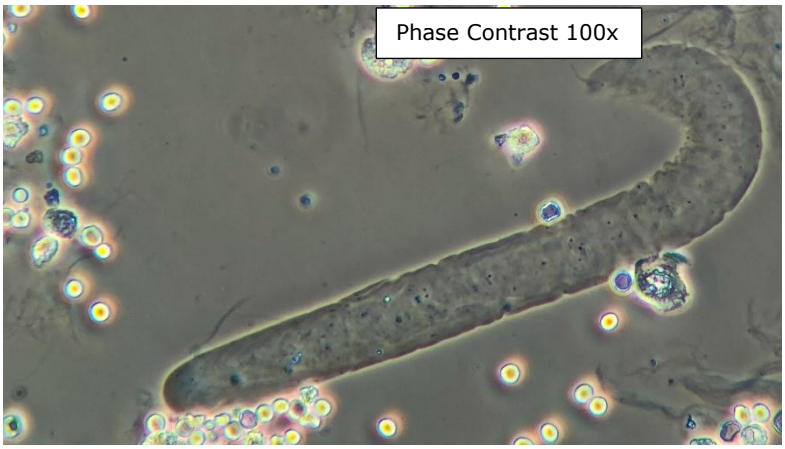
Characteristics: -Homogenous, but more highly refractive than hyaline casts (especially with 100x magnification).
-Usually broader with sharp contours, sometimes twisted, in which deep indentations may occur, depending on the location in the nephron where they are formed.

Clinical significance: -Acute and chronic kidney disease, due to prolonged oliguria or anuria in the affected nephron.







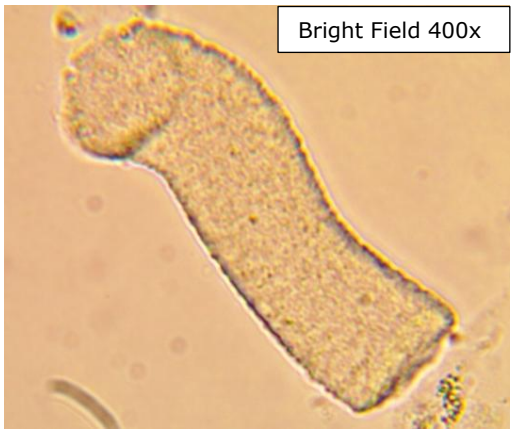


Waxy casts:

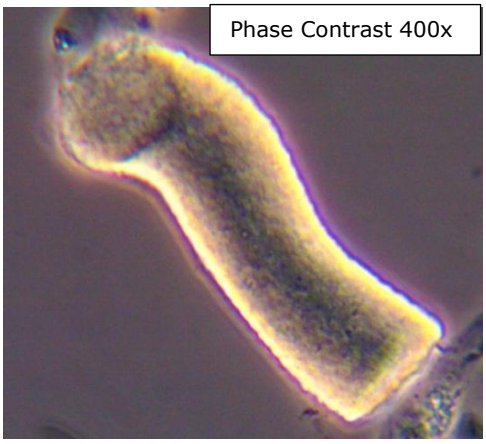
Bright Field 400x

Phase Contrast 400x

Bright Field 400x



Phase Contrast 400x



Bright Field 400x

Phase Contrast 400x

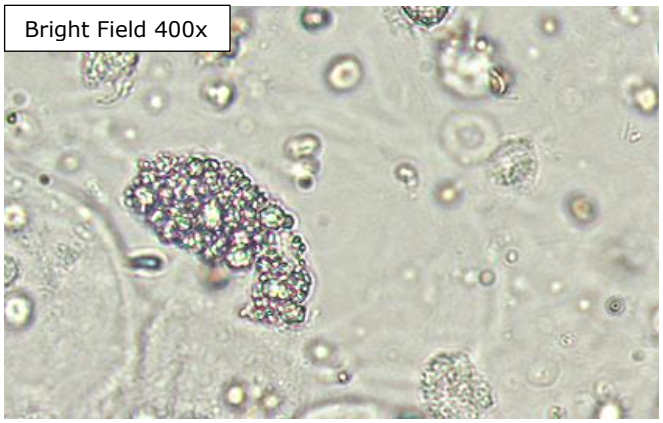
Grease casts:

Consists of: - Hyaline casts containing fat droplets or fat cells. Fat cylinders often occur together with free fat droplets in urine.

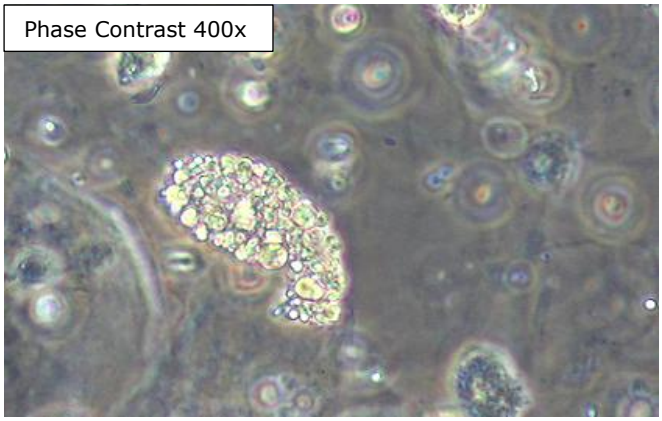
Characteristics: - A symmetrical Maltese cross is seen with polarized light.
- Fat can optionally be stained with Sudan III or Oil Red O.

Clinical significance: - In nephrotic syndrome, protein loss > 3.5 grams/24 hours.

Bright Field 400x

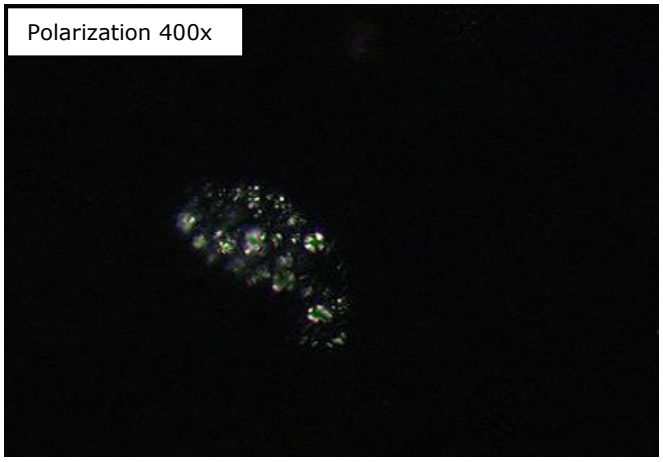


Phase Contrast 400x

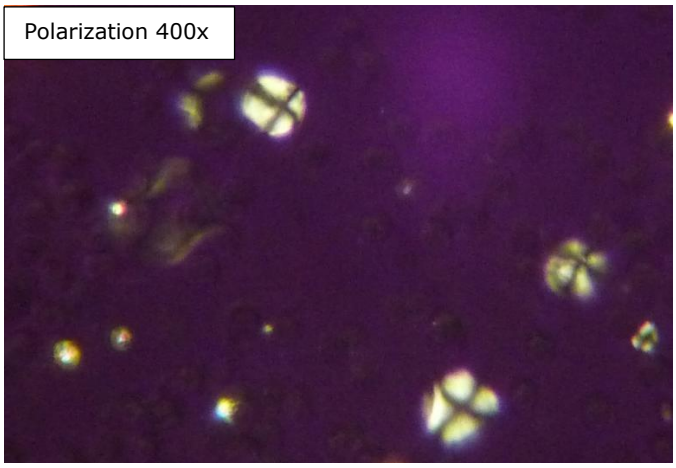


Maltese cross

Polarization 400x

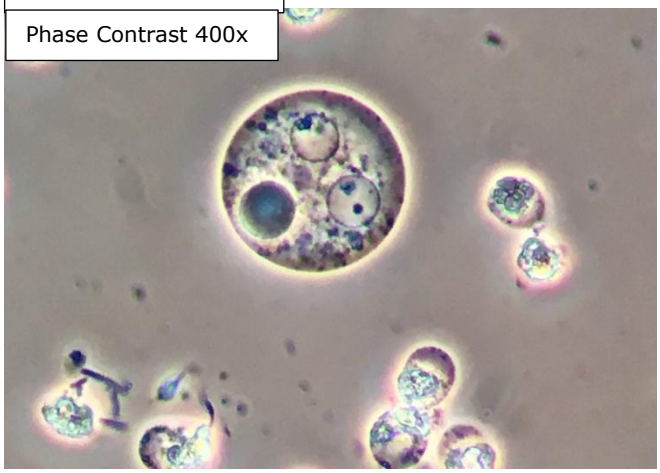


Polarization 400x



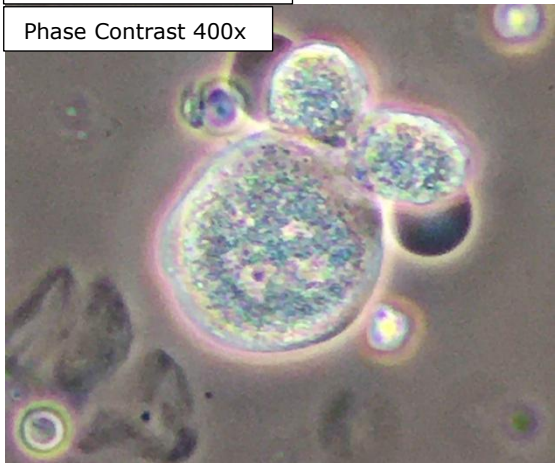
Macrophage

Phase Contrast 400x



Oval fat body

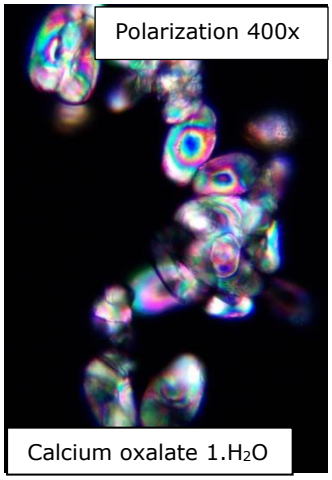
Phase Contrast 400x

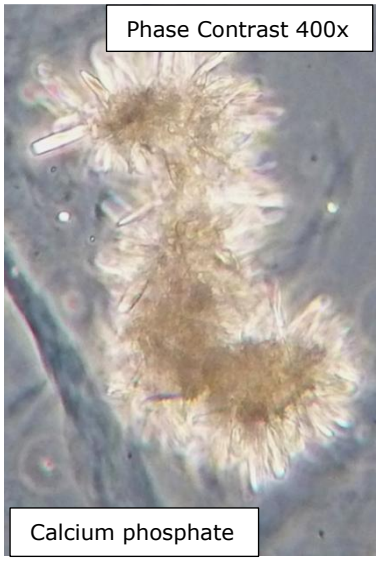


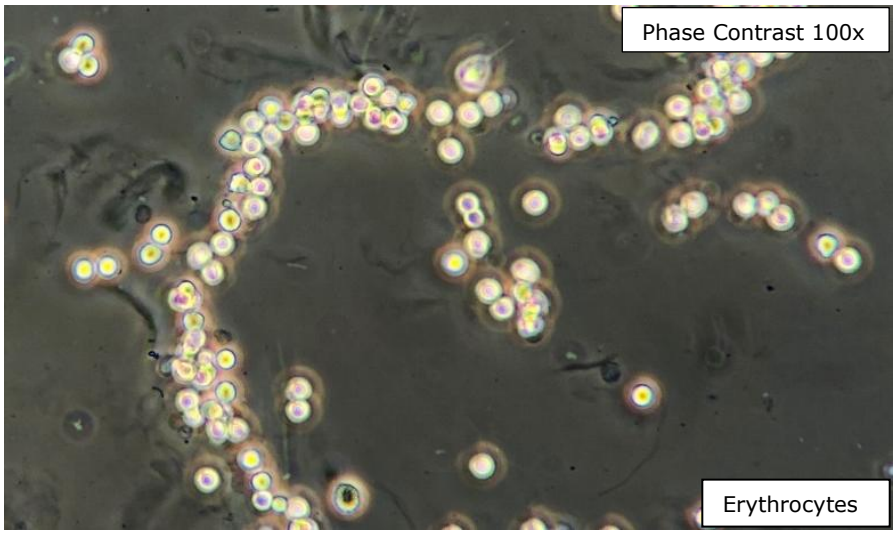
Pseudocasts:

When centrifuging urine, cylindrical clumps may occur. These are called pseudocylinders. These pseudocylinders often consist of oxalate crystals, cells, or amorphous salts. The cylinders can often be recognized by the absence of a distinct cylindrical matrix. If amorphous salts are present, one can attempt to dissolve them. For amorphous phosphate, this can be done by acidifying the sediment with acetic acid, and for amorphous urate, by heating the sediment to approximately 40°C.

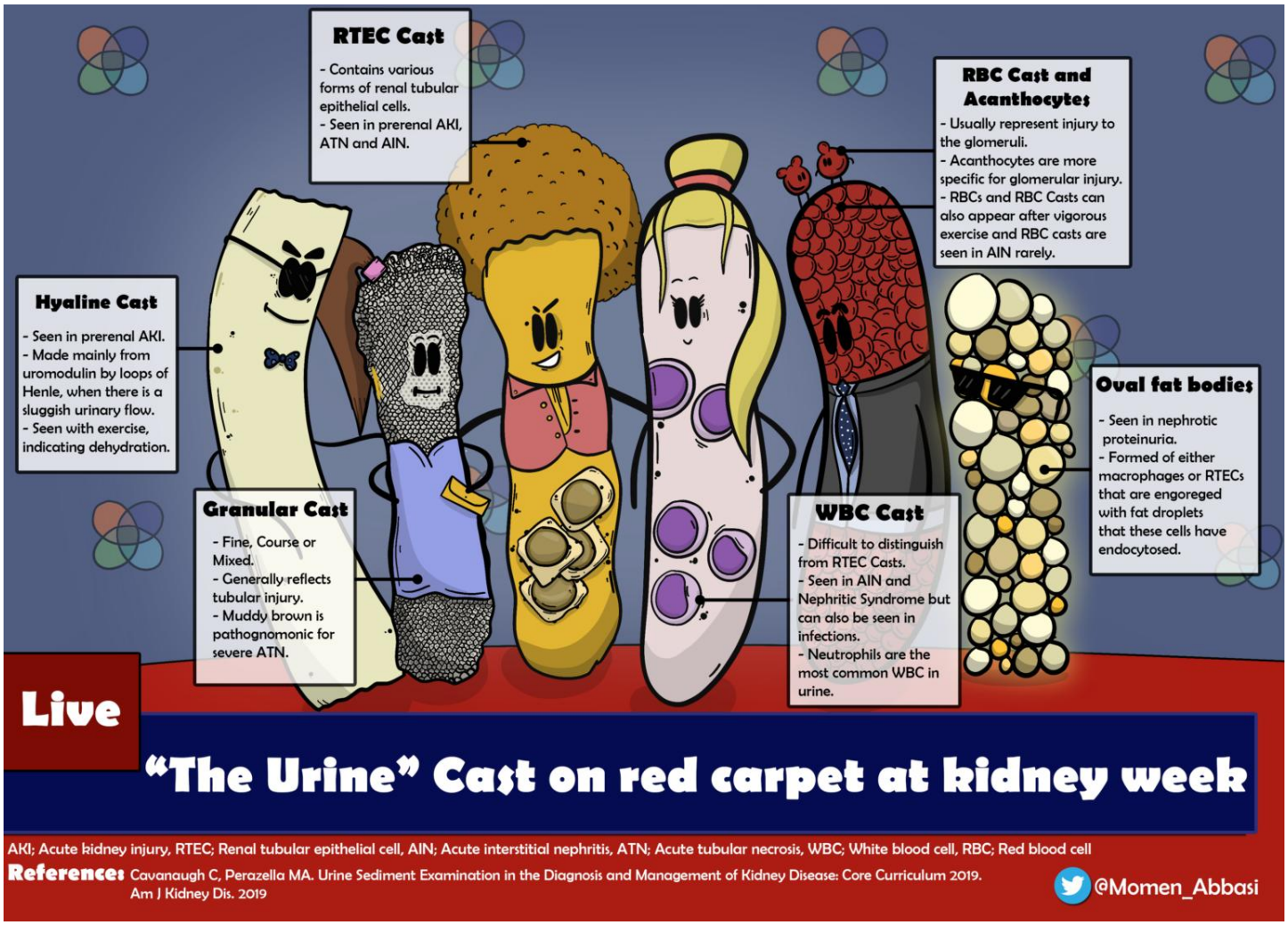
Clinical significance: - Not pathological.







Cast Comics by Nephrologist Momen Abassi:

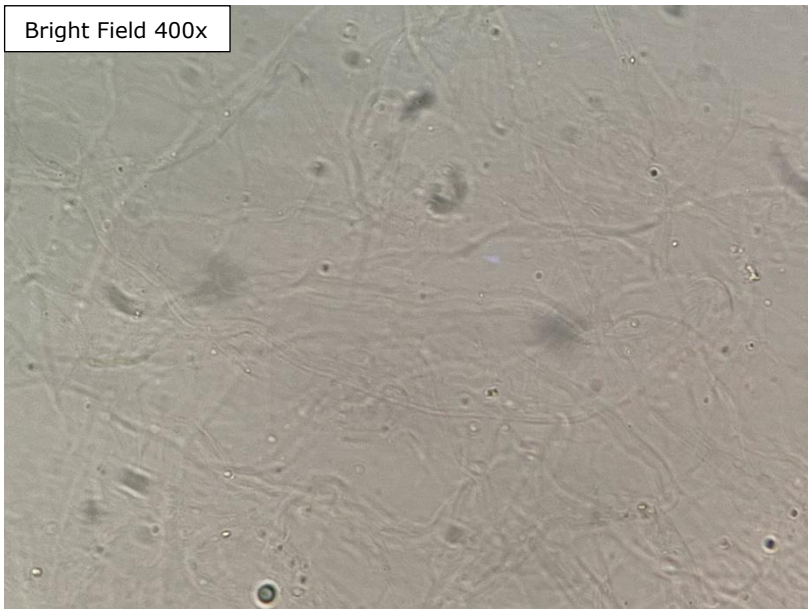


Mucus:

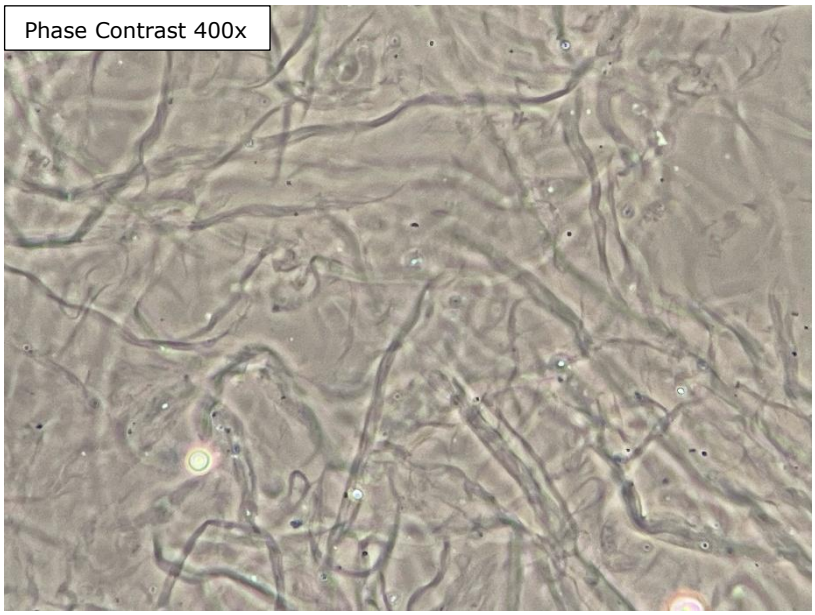
Mucus is visible as a stringy, hazy mass throughout the specimen. Mucus threads can sometimes be confused with hyaline casts. However, they do not have rounded ends, but usually taper to a point.

Clinical significance: - Not pathological

Bright Field 400x



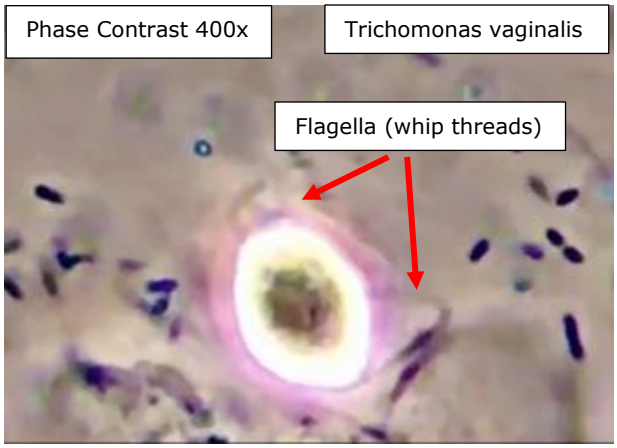
Phase Contrast 400x



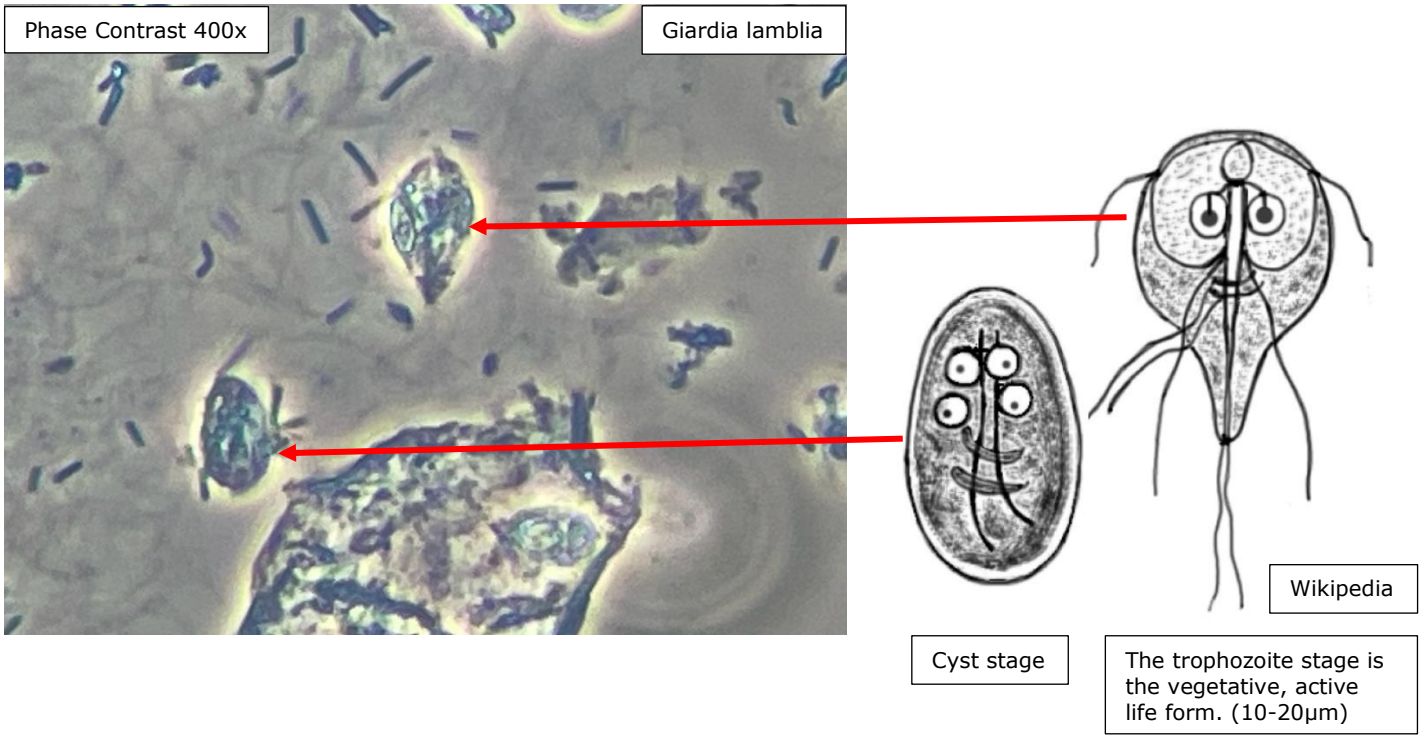
Parasites:

The most common parasite in urine is Trichomonas vaginalis. These flagellates are round/oval-shaped and have four fine flagellar filaments that originate from a single point in the cell membrane. They are approximately 15 µm in size. When the urine is still fresh, these parasites are highly motile and therefore easy to recognize. Dead parasites have lost their motility and can be confused with round epithelial cells. They can often be recognized by the small break in the cell membrane from which the flagellar filaments originate. Worm eggs are sometimes also seen in the urine.

Clinical significance: - Causes vaginitis or urethritis (male).



Giardia lamblia is a parasite usually found in fecal samples, not urine. Although giardiasis can cause gastrointestinal symptoms, it is not a urinary tract infection and usually does not affect the kidneys or bladder.



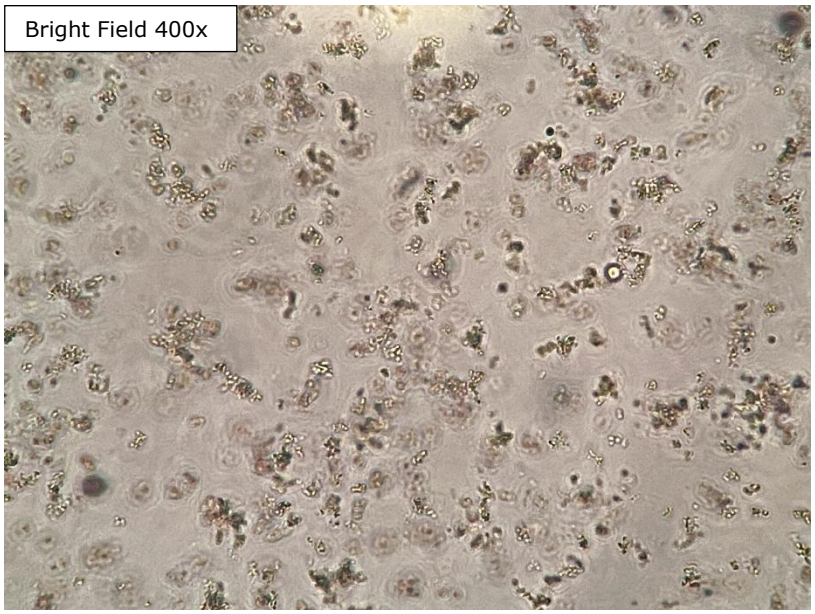
Amorphous salt:

Urate and phosphate can form an amorphous, granular precipitate when the urine cools. Morphologically, urate and phosphate are indistinguishable. The precipitate can be so abundant that it makes assessing the sediment impossible. This problem can be solved as follows. Urate occurs only in acidic urine (pH < 6.0) and usually disappears after gently warming the sediment to approximately 40 degrees Celsius (e.g., with lukewarm water). Phosphate occurs in alkaline urine (pH > 6.5) and can be dissolved by acidifying the sediment with one drop of acetic acid.

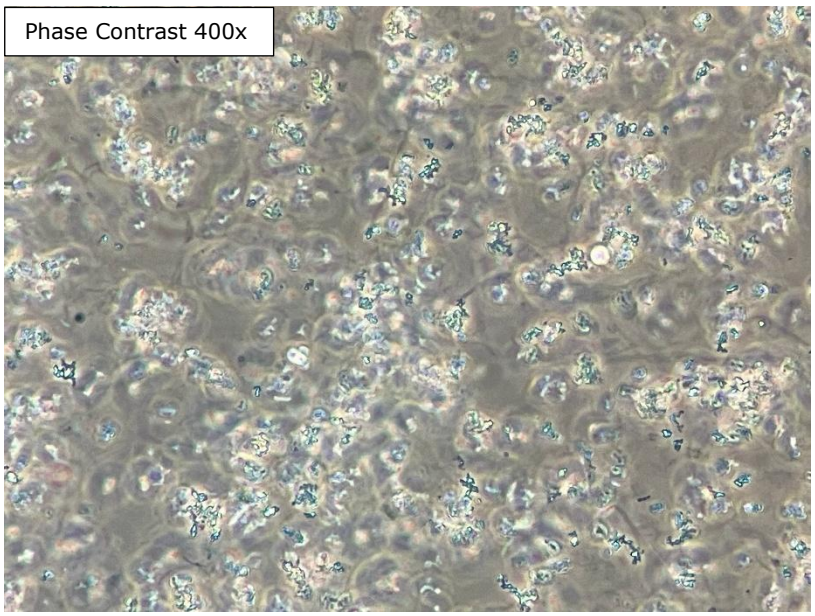
Clinical significance: - Not pathological.

Amorphous Urate, Sedimentum Lateritium

Bright Field 400x



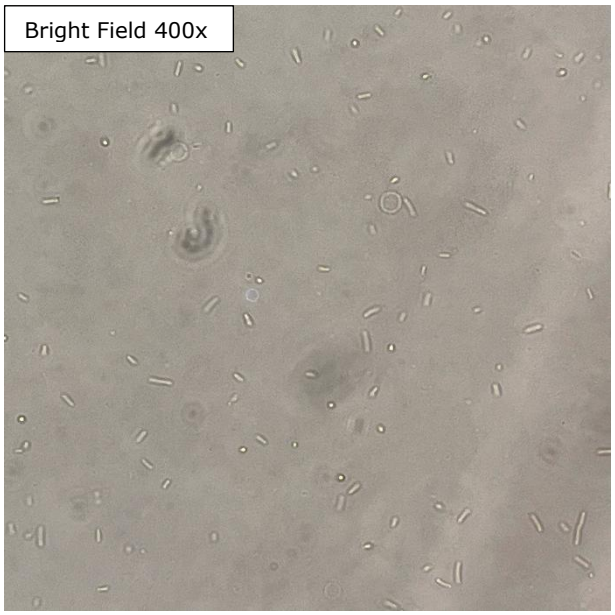
Phase Contrast 400x

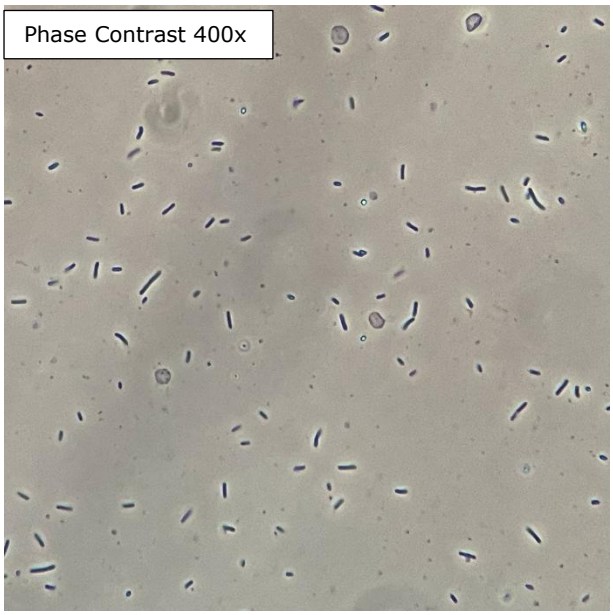


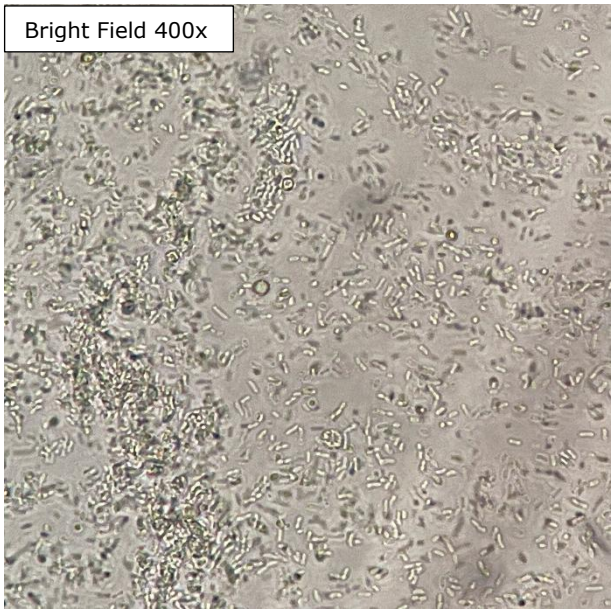
Bacteria:

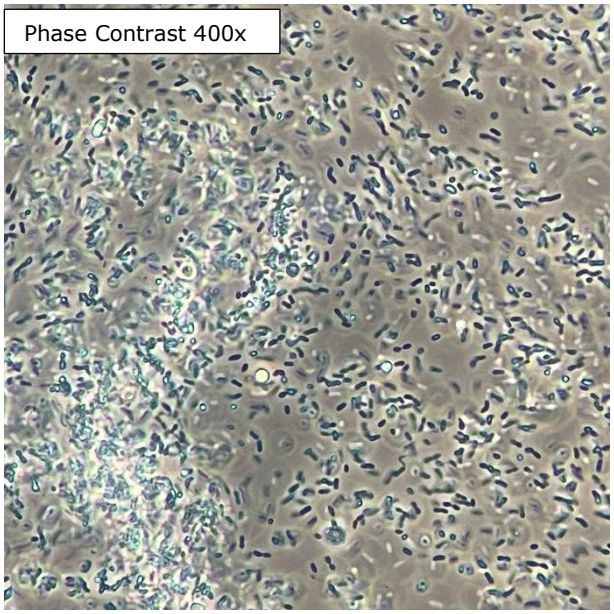
Small round (1 µm) or rod-shaped (5 µm) elements can be found in urine. These can exhibit vibratory movements (Brownian motion). Sometimes they are found in clusters (chains or disordered).

Clinical significance: - Urinary tract infection (in association with leukocytes).
- Contaminated urine.





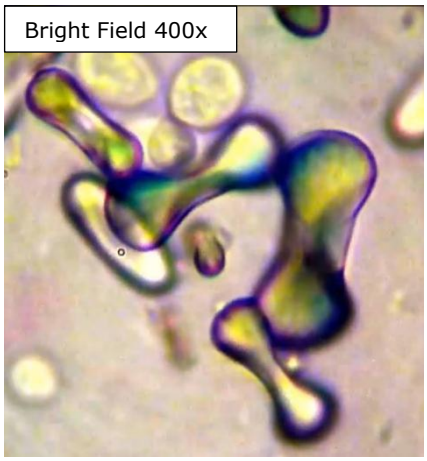


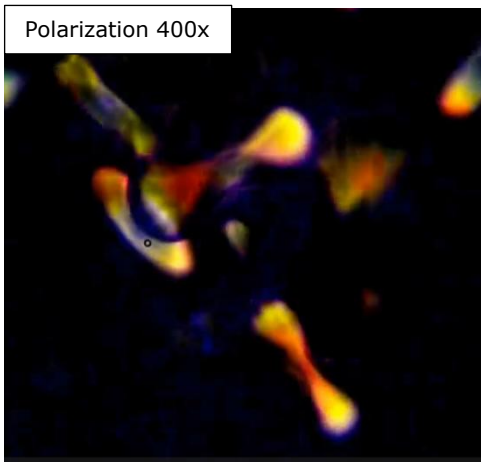


Calcium oxalate crystals:

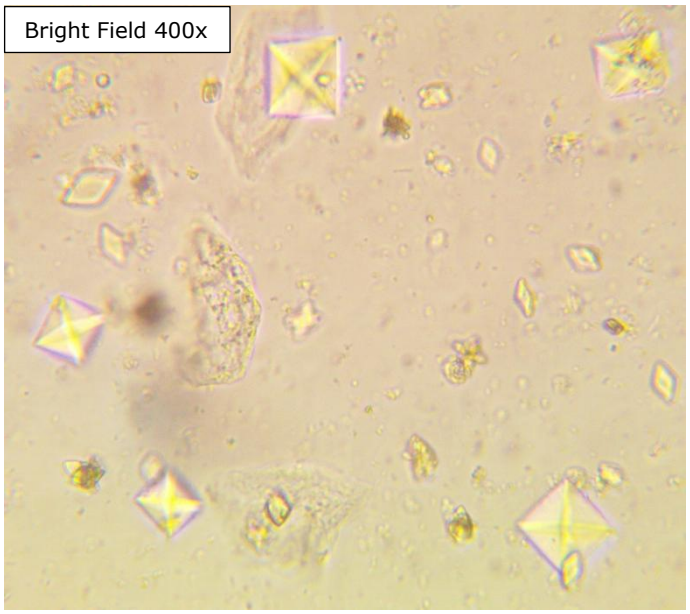
Clinical significance: - Generally not pathological, but high calcium concentrations in the urine can lead to stone formation.

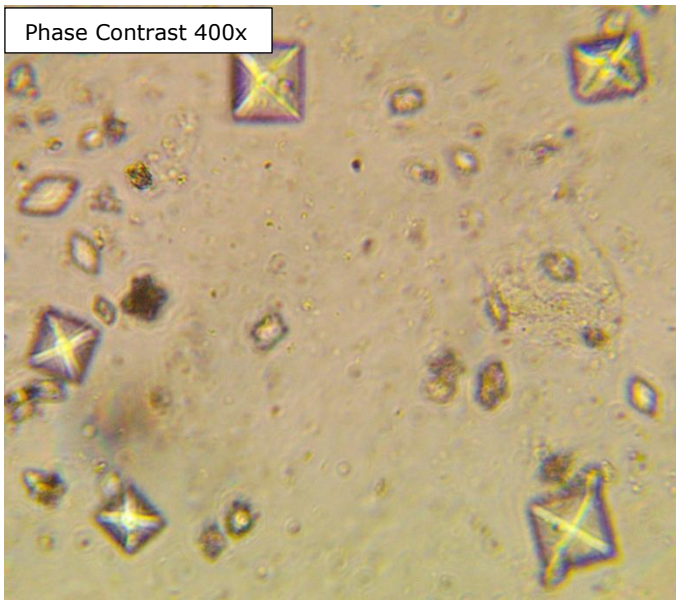
Calcium oxalate 1.H_2O





Calcium oxalate 2.H_2O

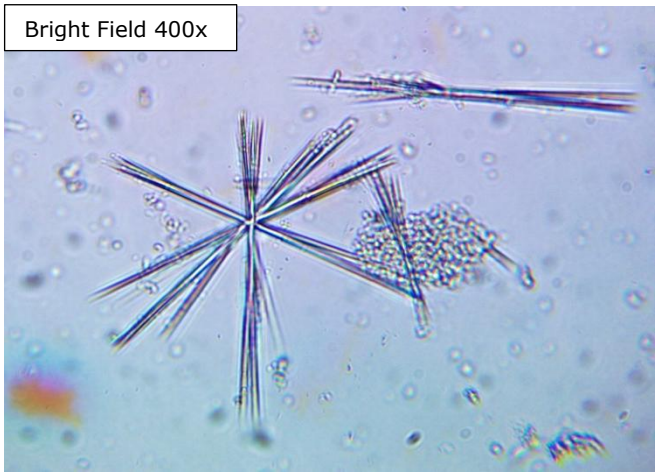




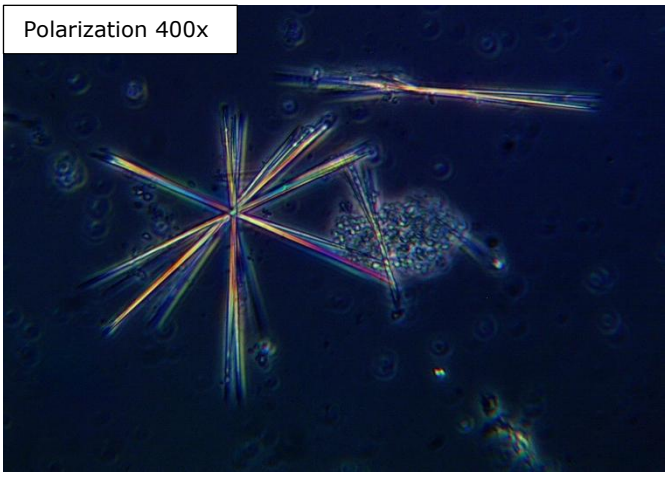
Calcium phosphate crystals:

Clinical significance: - Generally not pathological, but high calcium concentrations in the urine can lead to stone formation.

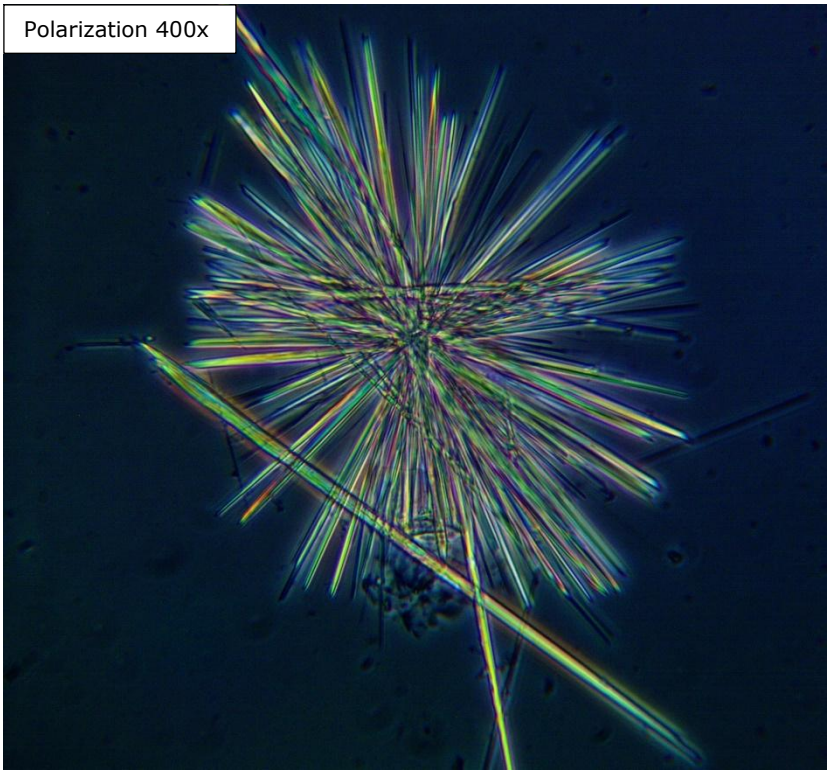
Bright Field 400x



Polarization 400x

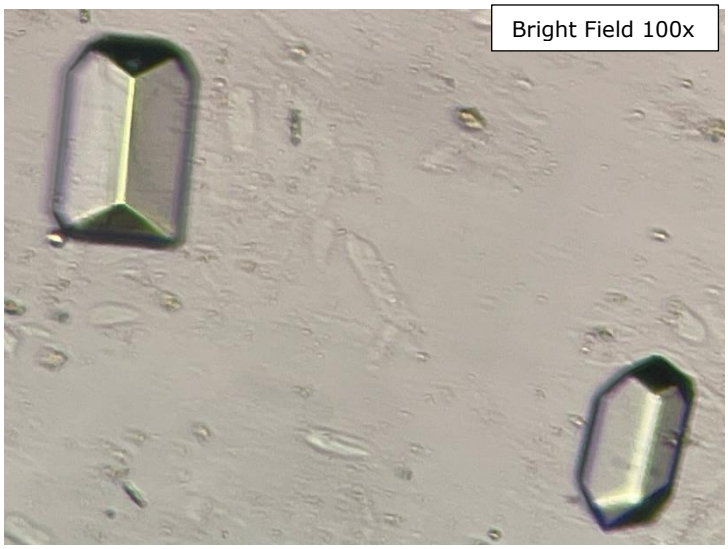


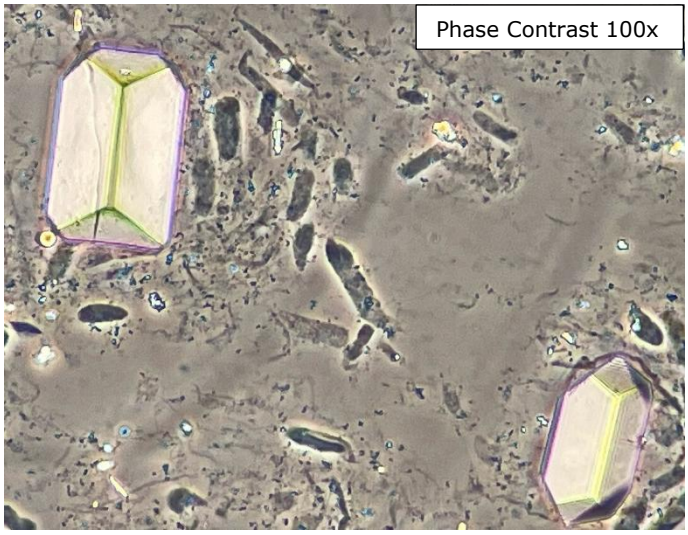
Polarization 400x

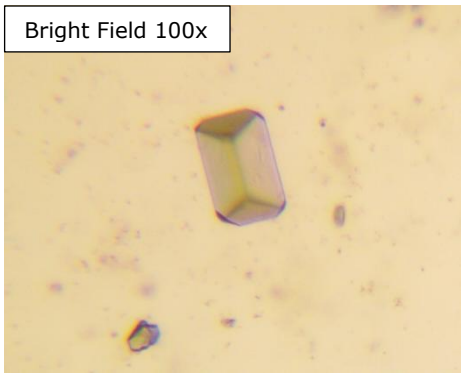


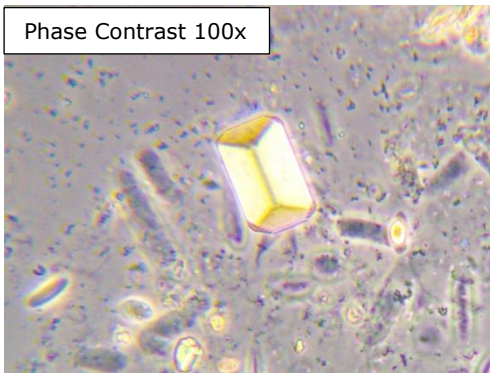
Magnesium Ammonium Phosphate (Triple Phosphate/Struvite) Crystals:

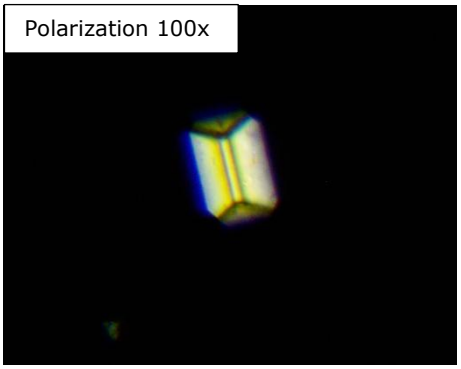
Clinical significance: - Occurs at an alkaline pH due to an upper urinary tract infection with urease-producing bacteria.







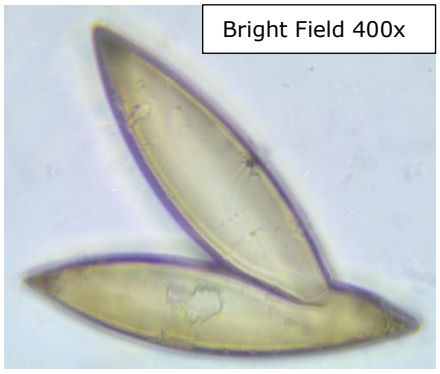


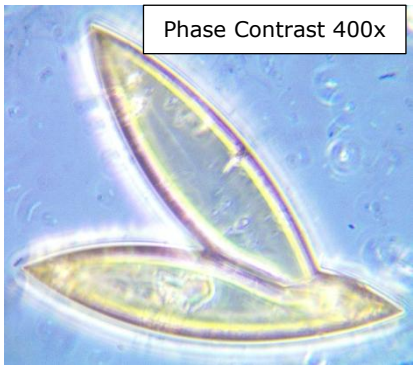


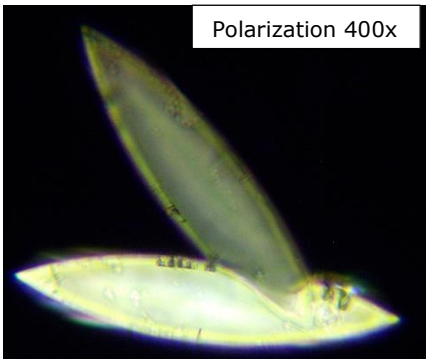
Uric acid crystals:

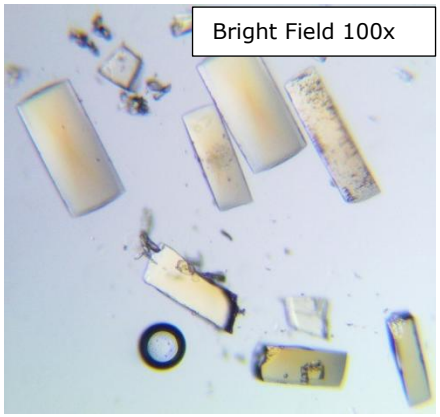
Clinical significance: - Not pathological.

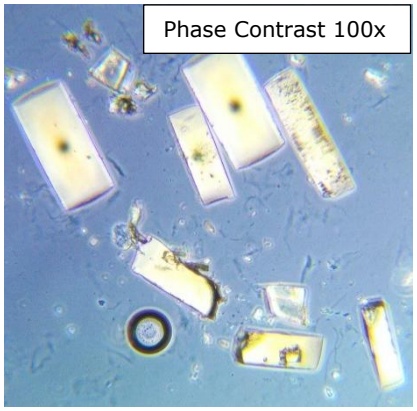
- Frequently observed in patients with gout. In primary and secondary gout, uric acid excretion in urine is often elevated; the presence of uric acid crystals in the sediment alone does not prove the diagnosis. The pathogenesis of primary gout is based on increased uric acid formation and/or decreased renal uric acid excretion. Secondary gout occurs as a result of increased nuclear destruction (e.g., in psoriasis, polycythemia, leukemia, cytostatic drugs, and radiotherapy). Uric acid crystals occur in very different forms: as rhombic prisms in rolls or clusters, rosettes, rectangular or hexagonal plates. With the exception of ammonium urate, all uric acid and urate crystals are found in acidic urine. The result is only reported when large numbers of crystals are present.

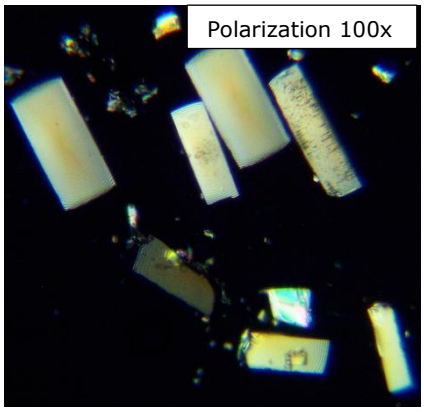


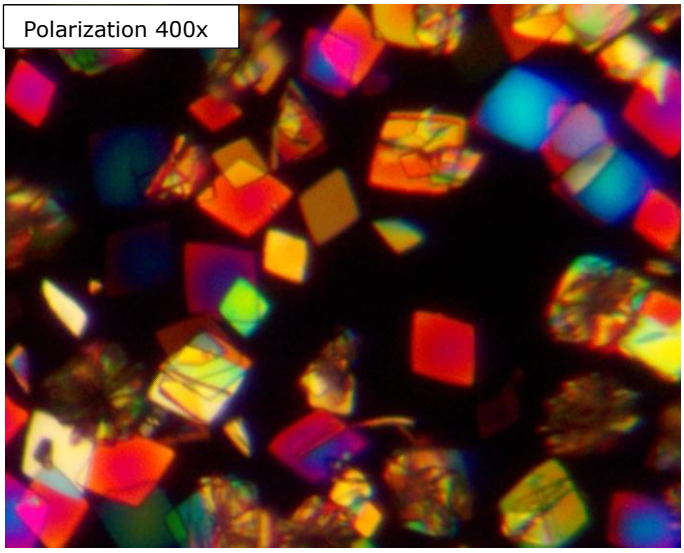








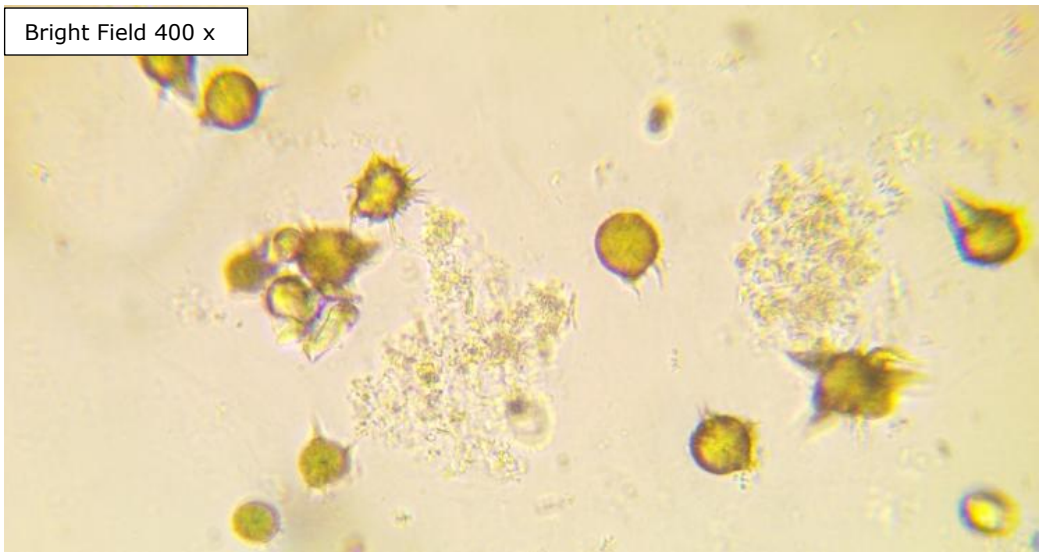




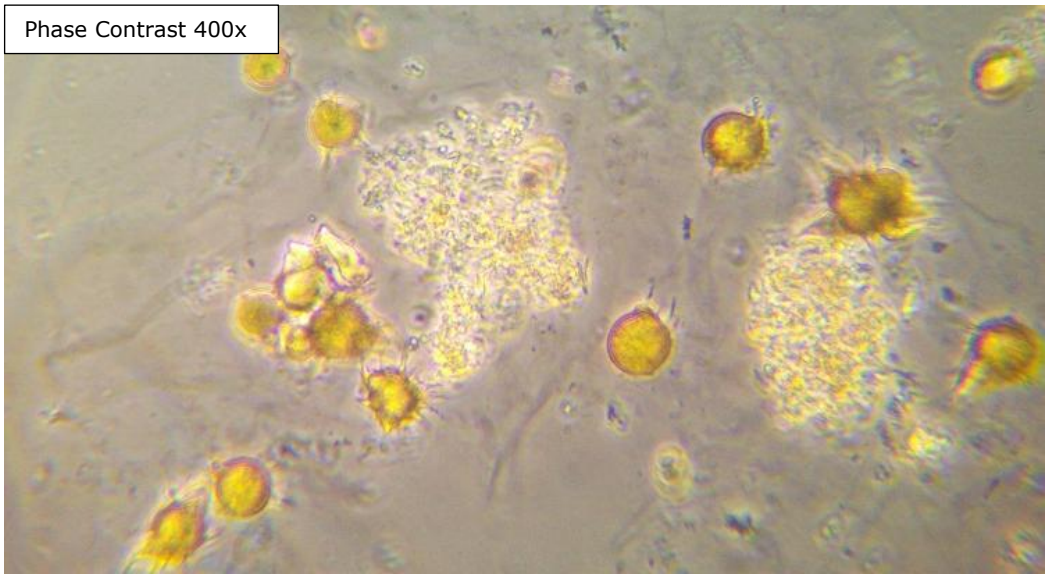
Ammonium urate crystals:

Ammonium urate is found only in alkaline urine.

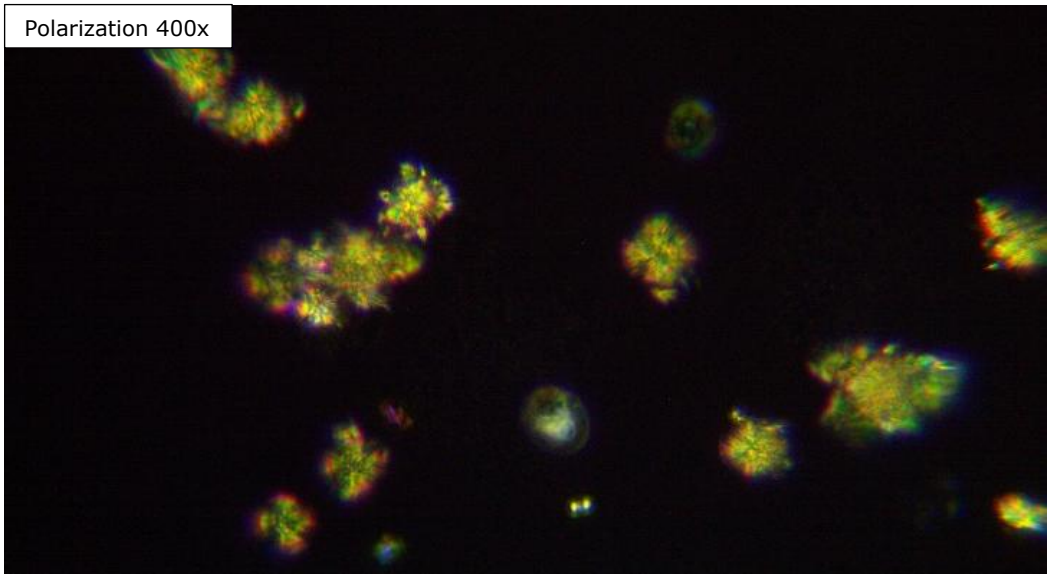
Bright Field 400 x



Phase Contrast 400x



Polarization 400x

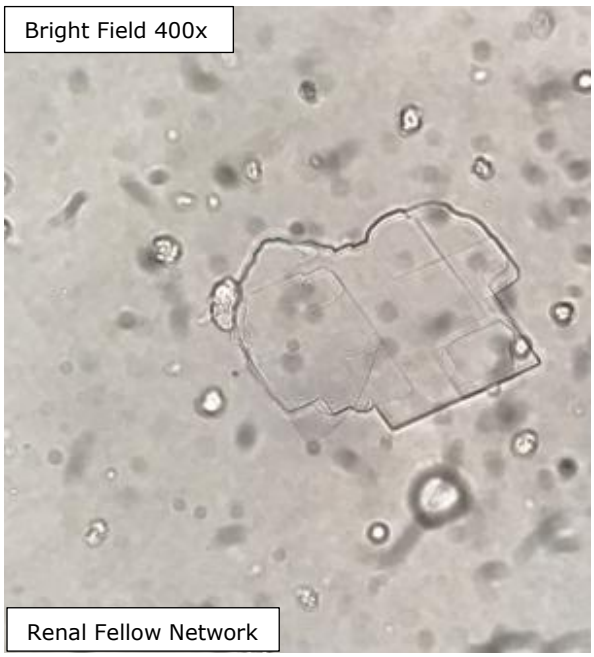


Cholesterol crystals:

Characteristics:
- Cholesterol crystals lie on top of each other as thin, polygonal plates with angular recesses.
- They have sharply defined edges and corners and may exhibit birefringence when polarized.
- Cholesterol crystals vary in size and are rarely found in urine.

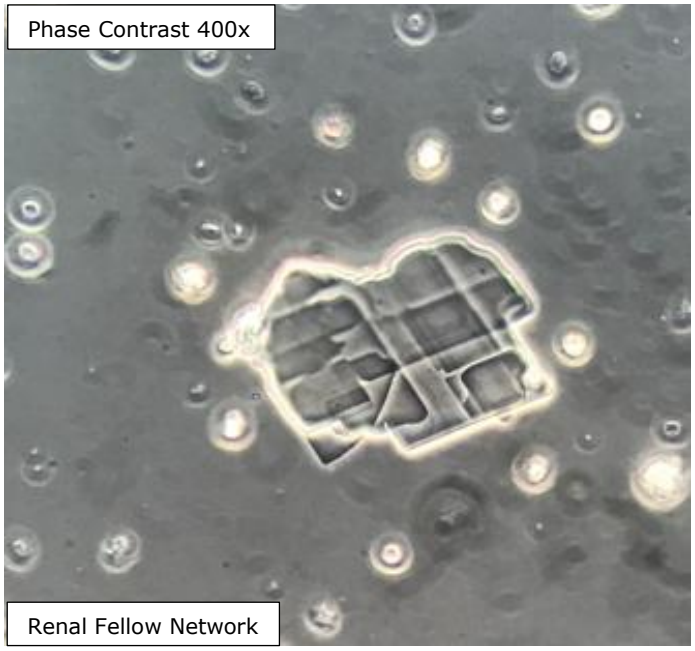
Clinical significance:
- Nephrotic syndrome.
- Chyluria.

Bright Field 400x



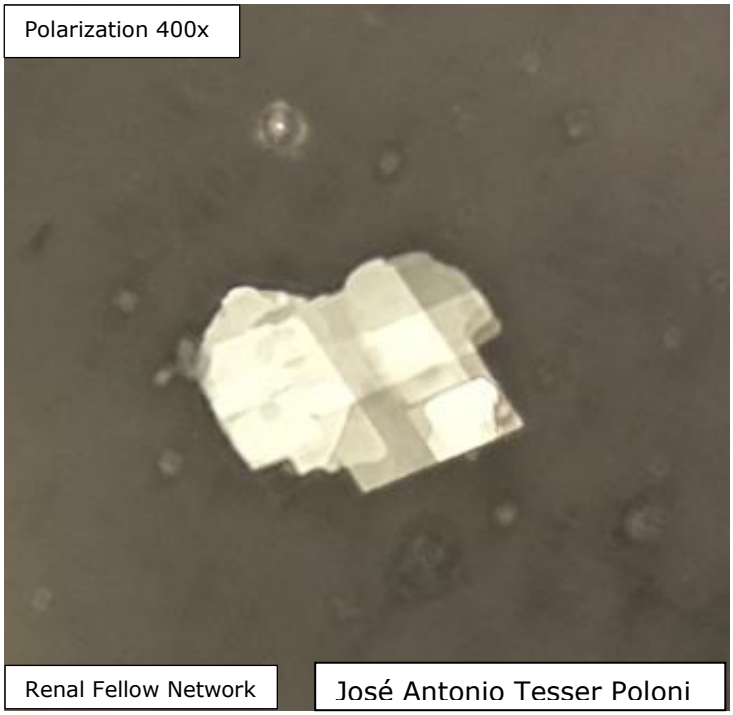
Renal Fellow Network

Phase Contrast 400x



Renal Fellow Network

Polarization 400x

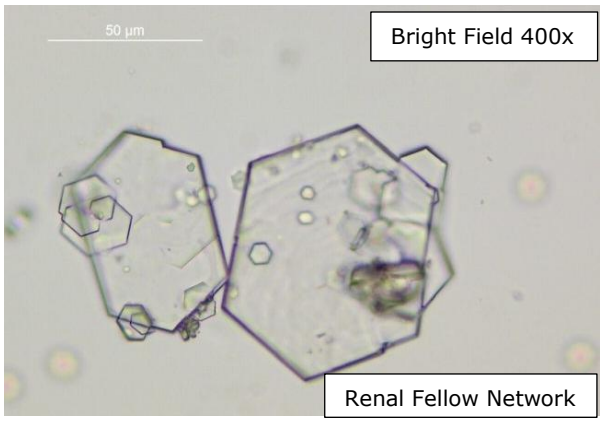


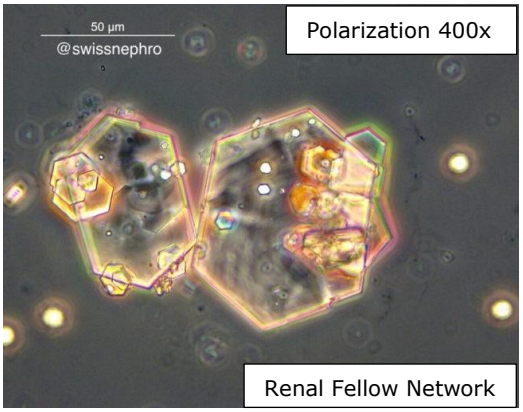
Renal Fellow Network

José Antonio Tesser Poloni

Cystine Crystals:

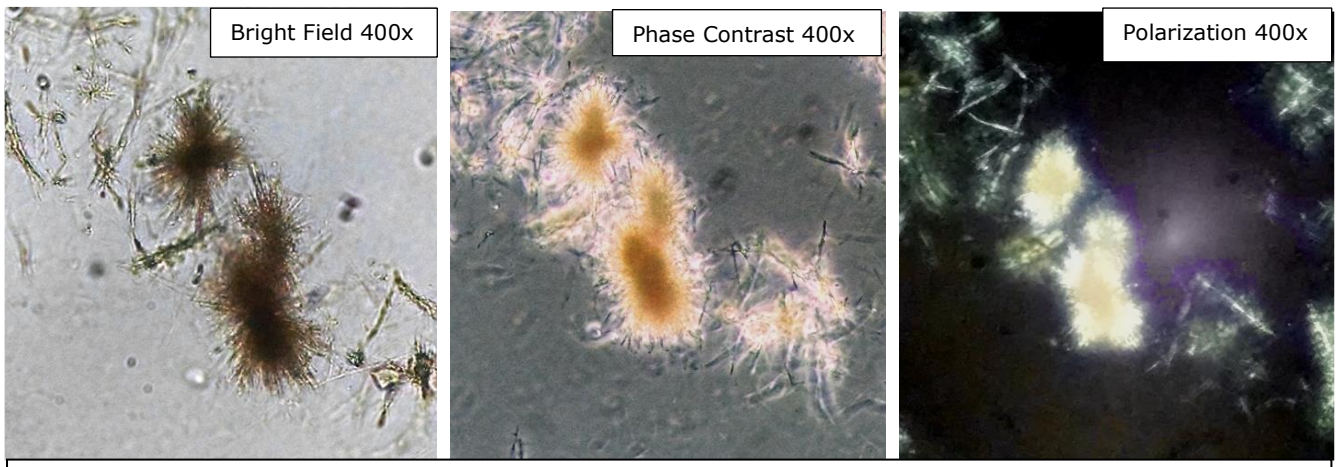
Clinical significance: - Pathological.
- Found in the urinary sediment in familial cystinuria. In addition to the formation of cystine bladder stones, extensive deposition of cystine crystals can occur in kidney tissue. The resulting extensive fibrosis of the renal parenchyma can lead to renal tubular dysfunction. The cystine crystals usually appear as colorless, hexagonal plates with a high refractive index.





Tyrosine Crystals:

Clinical significance: - Pathological.
- Tyrosine and leucine often occur together; they are amino acids that crystallize and can be found in severe liver damage. Tyrosine crystallizes in very fine, greenish-yellow needles in bunches or sheaves.

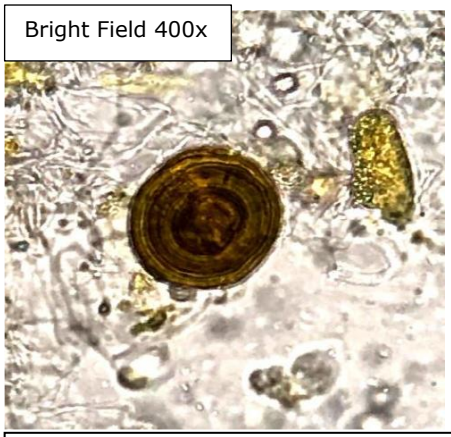


Mini atlas Urinalysis Urinary Sediment (2023) Controllab

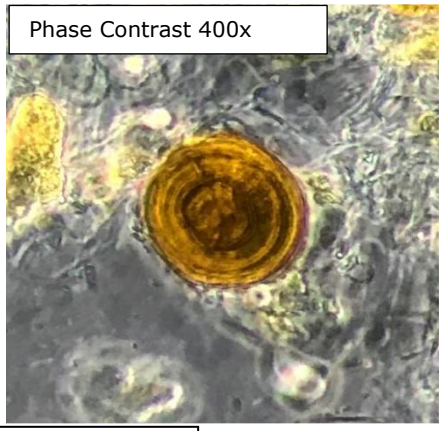
Leucine Crystals:

Clinical significance: - Pathological.
- Tyrosine and leucine often occur together; they are amino acids that crystallize and can be found in severe liver damage.

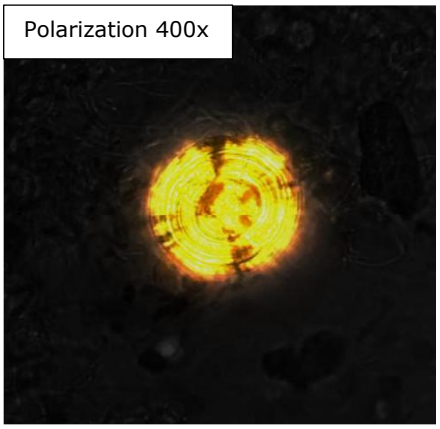
Bright Field 400x



Phase Contrast 400x

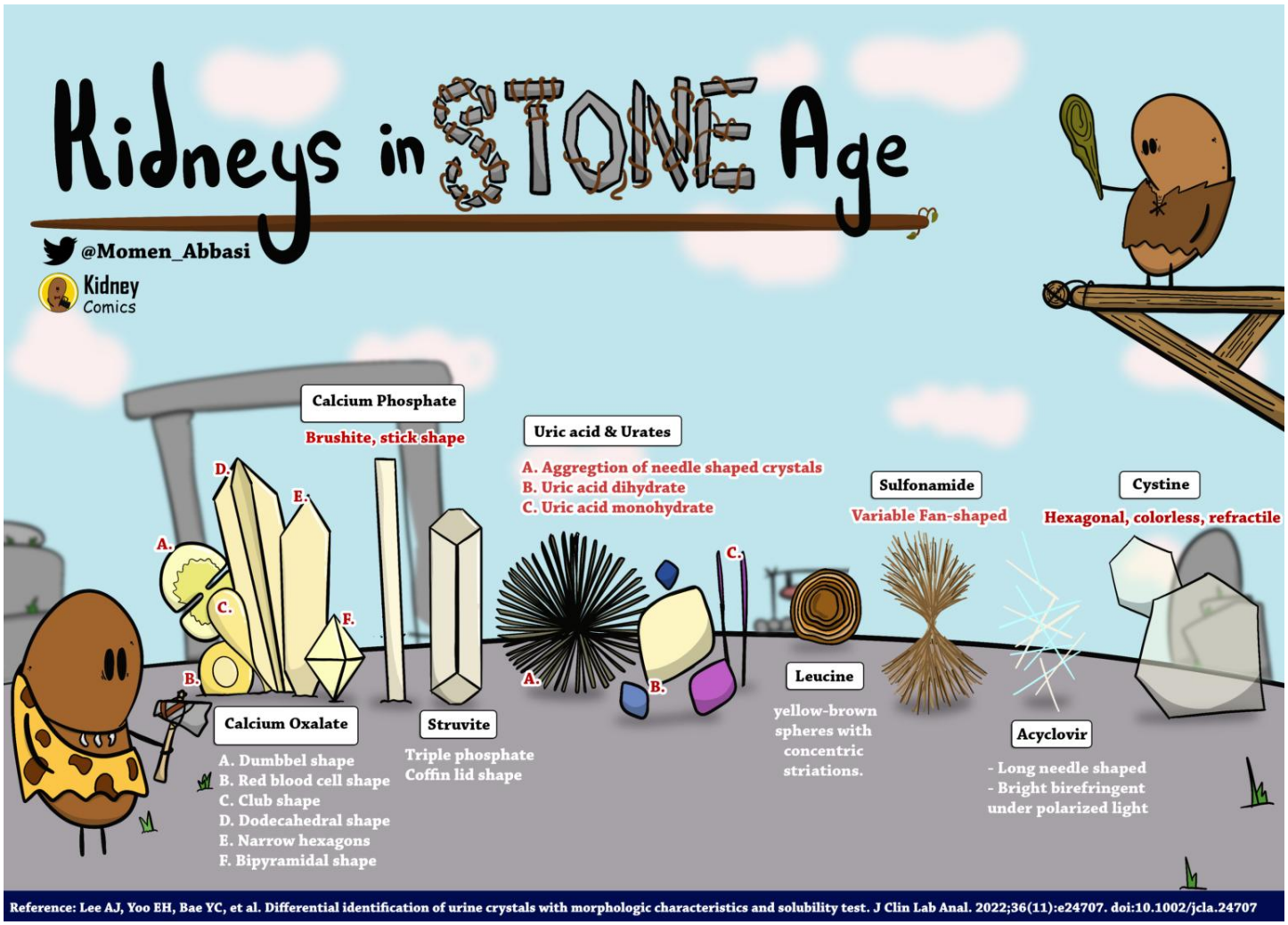


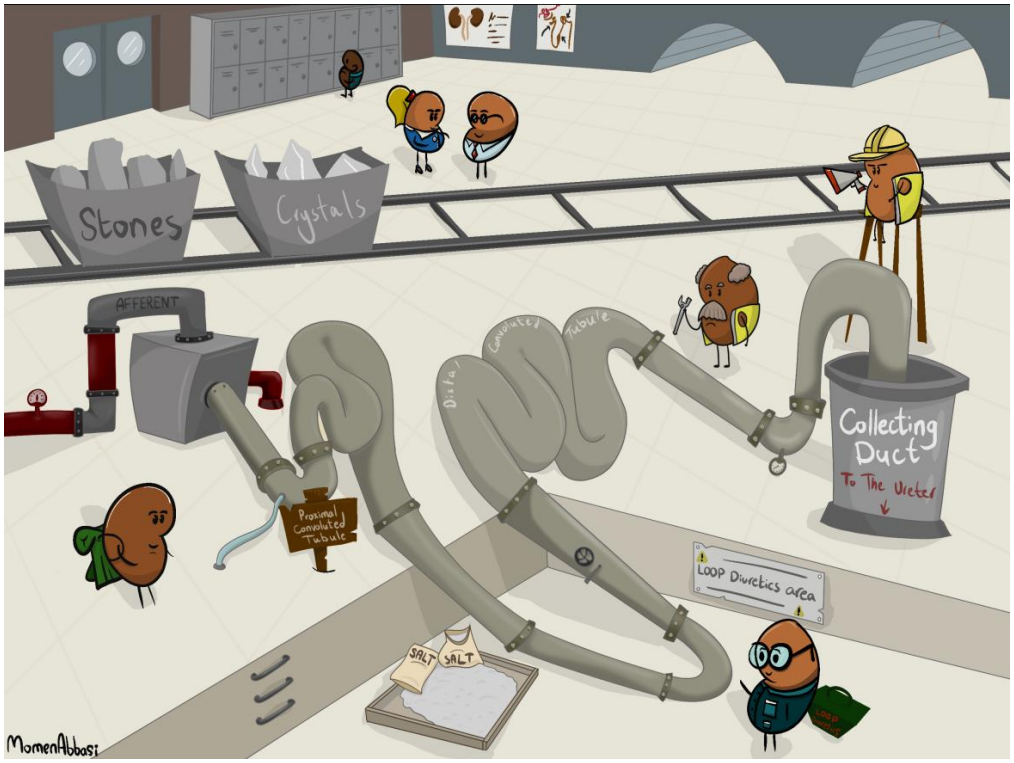
Polarization 400x



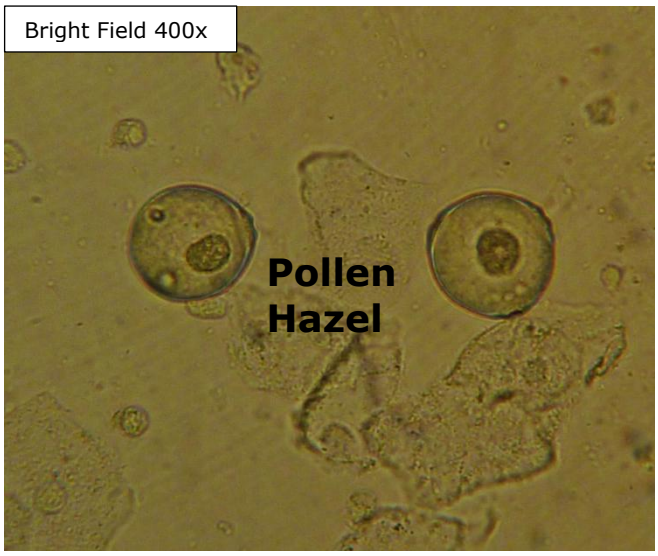
Mini atlas Urinalysis Urinary Sediment (2023) Controllab

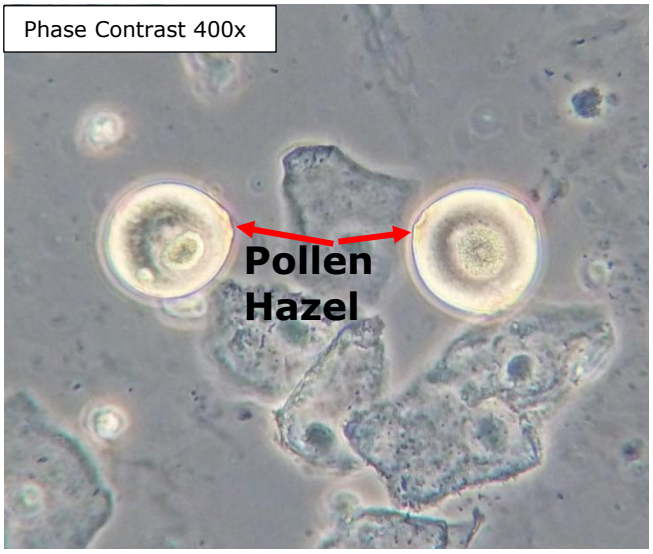
Kidney Stone Comics by Nephrologist Momen Abassi[11]:

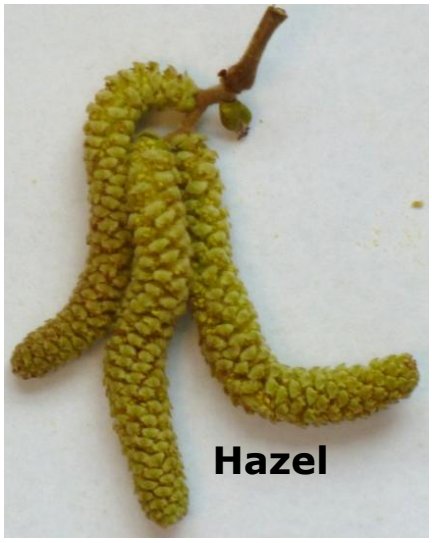




Impurities in urine, pseudo-round epithelium/Transitional epithelium:



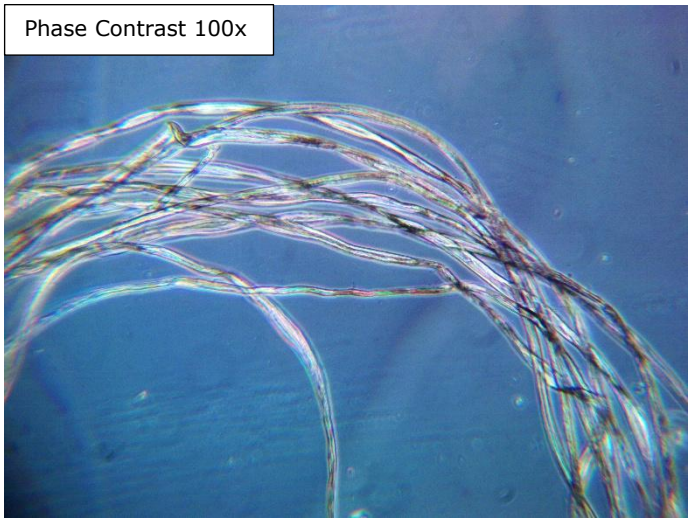




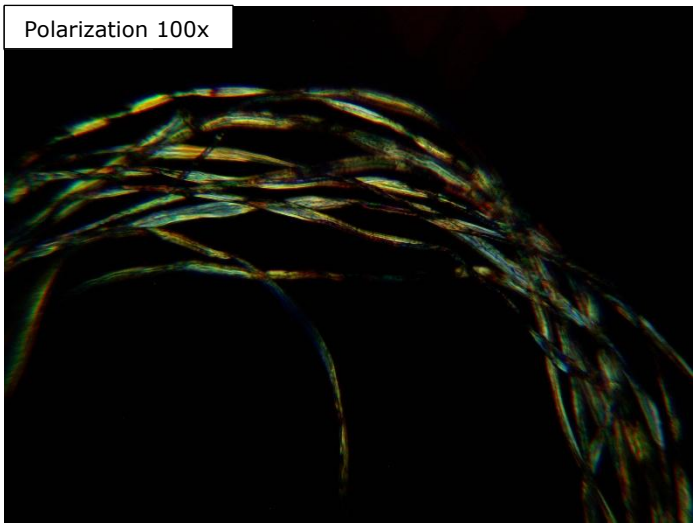
Contaminants in urine, Textile fiber/Paper fiber:

Textile fiber: Cotton, cotton wool, underwear, etc.

Phase Contrast 100x

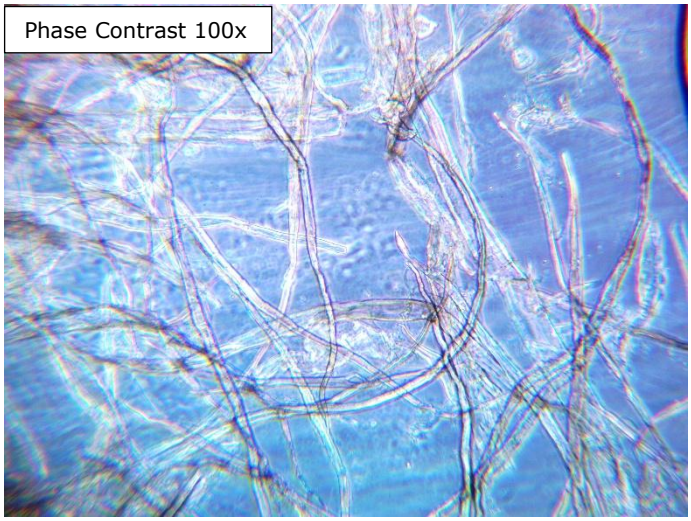


Polarization 100x

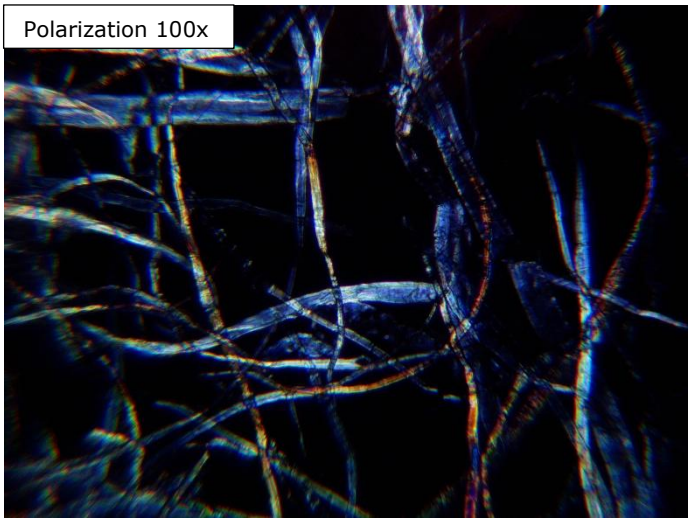


Paper fiber: Paper, toilet paper

Phase Contrast 100x

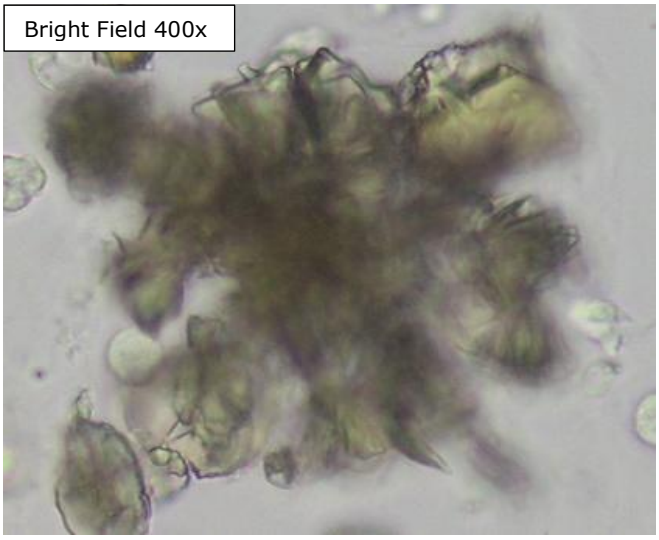


Polarization 100x

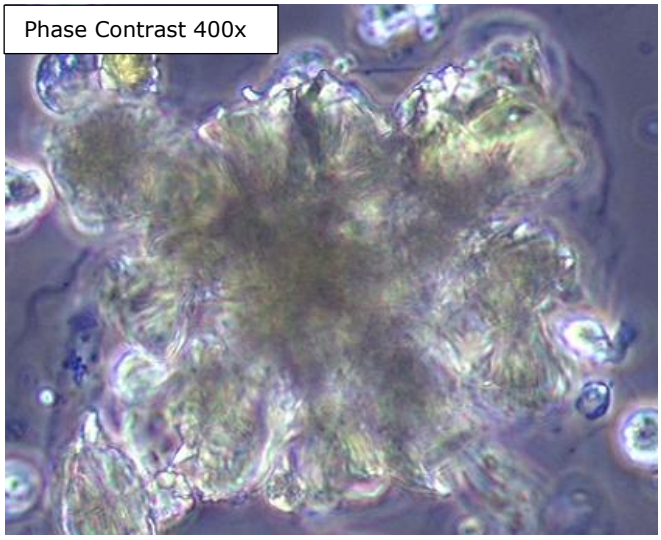


Impurities in urine, Talc:

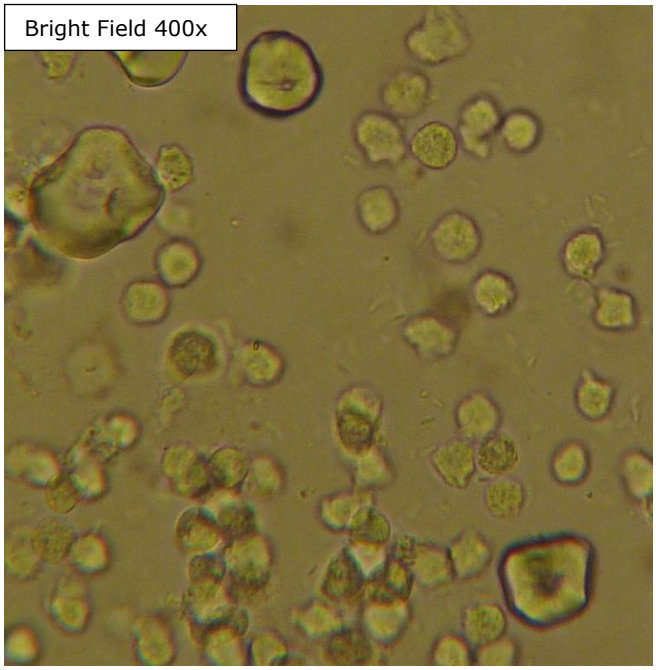
Bright Field 400x



Phase Contrast 400x

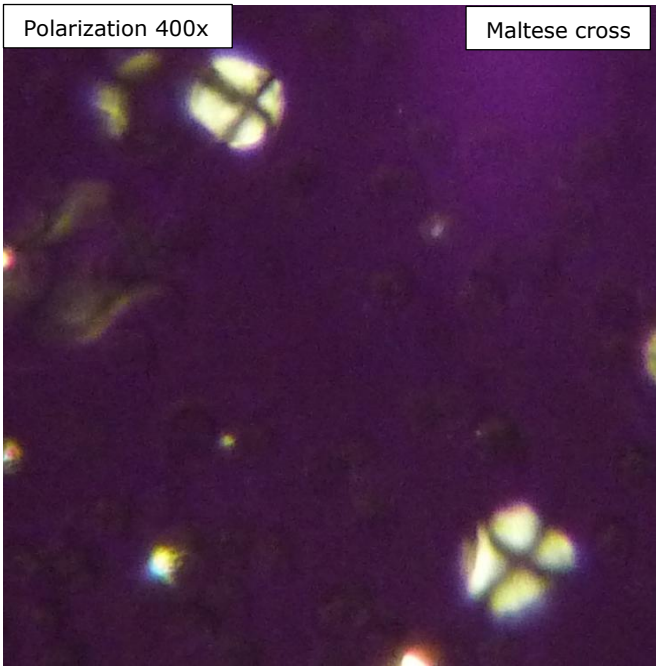


Bright Field 400x



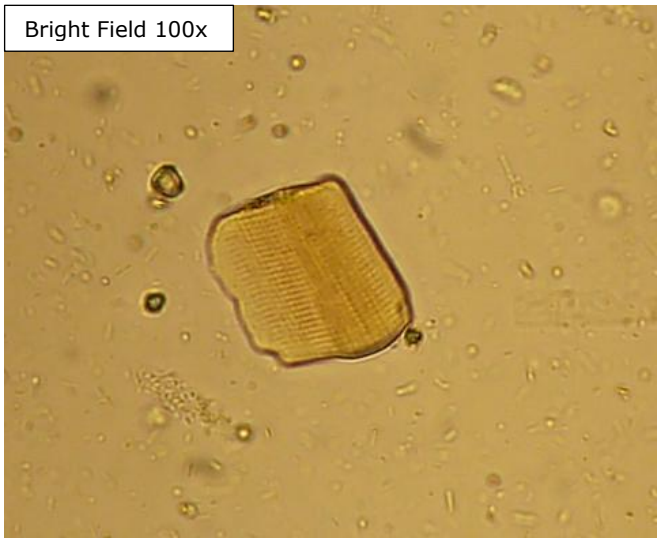
Polarization 400x

Maltese cross

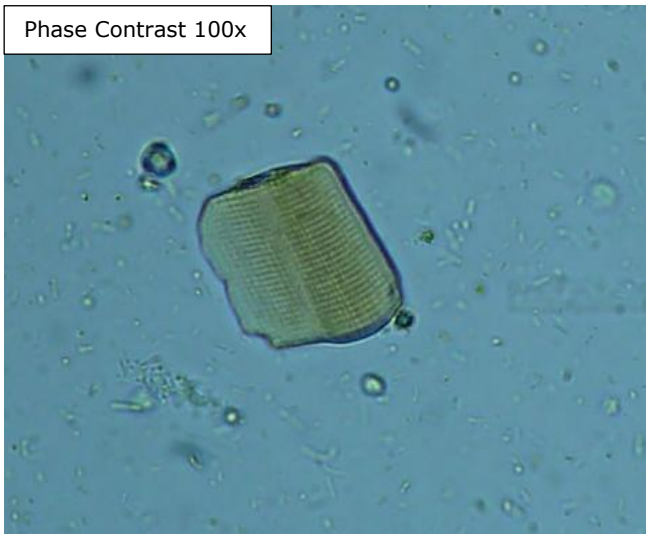


Impurities in urine, fecal muscle fiber:

Bright Field 100x

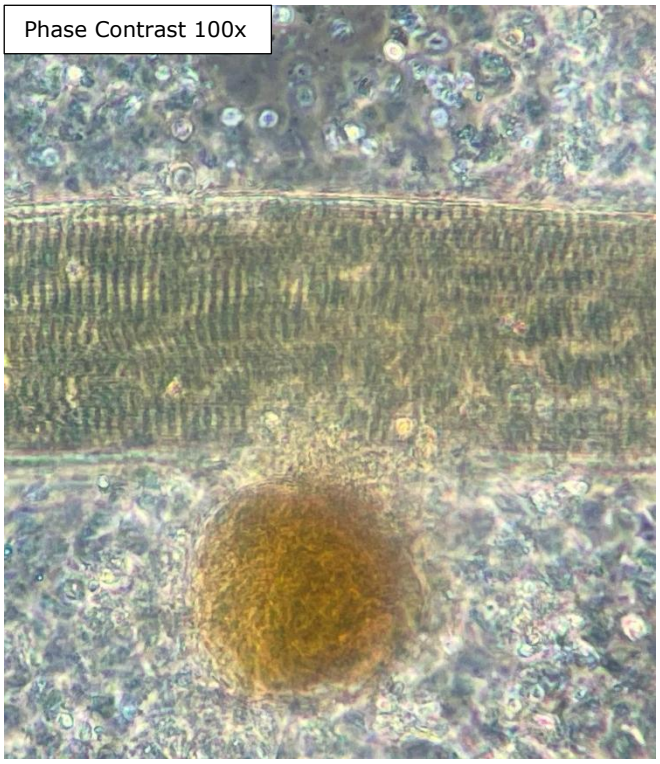


Phase Contrast 100x



Phase Contrast 100x

Phase Contrast 100x

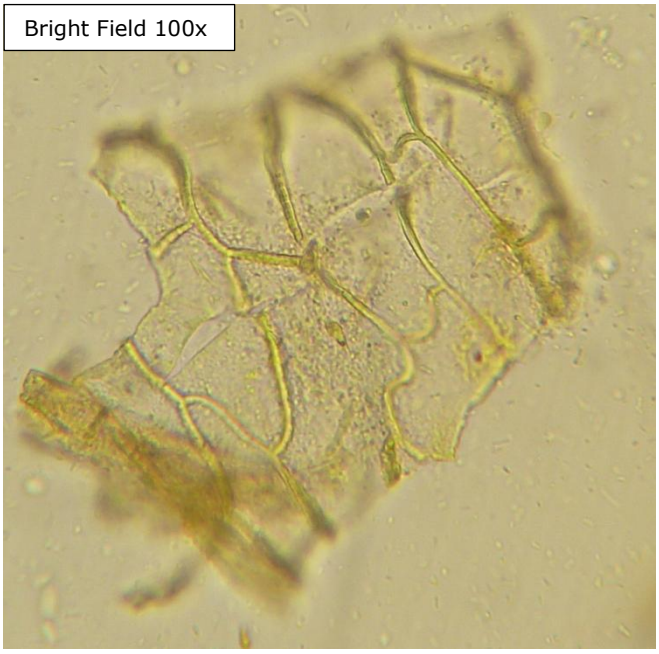


Contaminants in urine, feces, plant fibers:

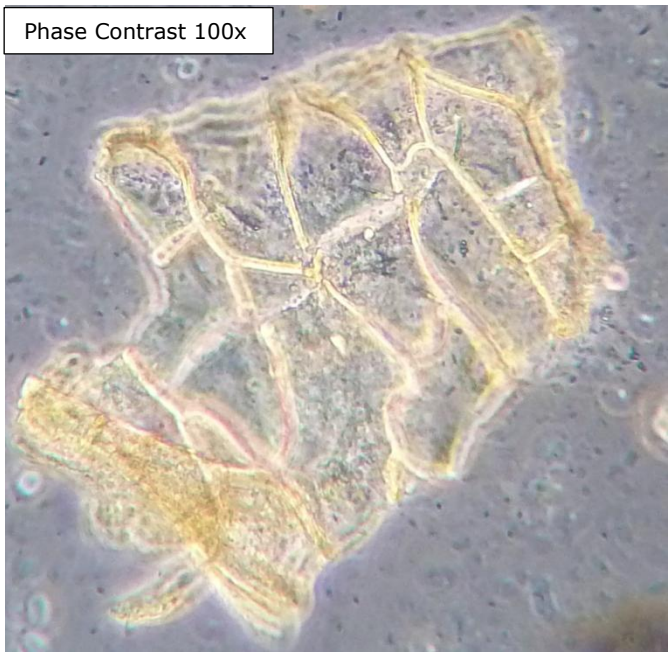
(See also Chapter 3: Urine fiber test: Enterovesical fistula).

- Plant fiber: Relatively large: Plant fiber cannot pass through the kidney.
- Visible with 100x magnification.
- Plant cells have a membrane and a cell wall.
- Often highly refractive with phase contrast.

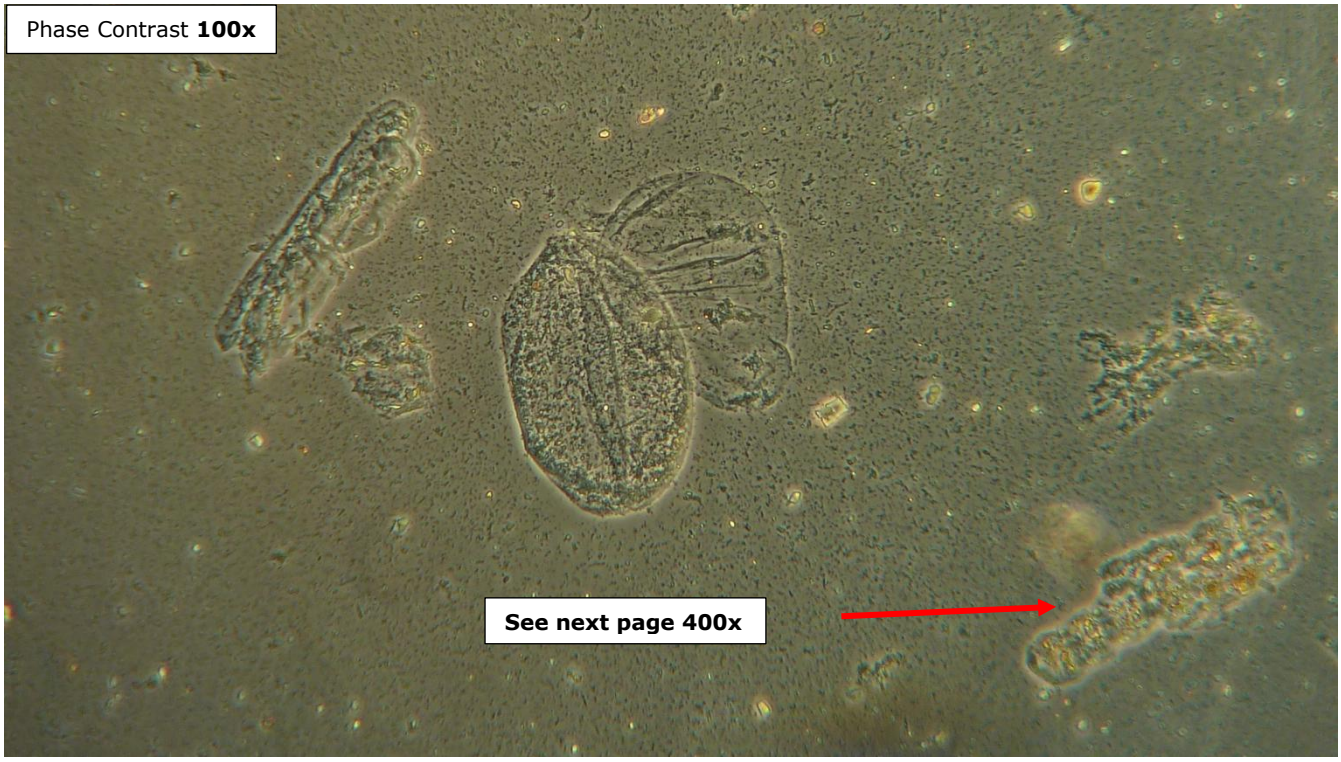
Bright Field 100x



Phase Contrast 100x

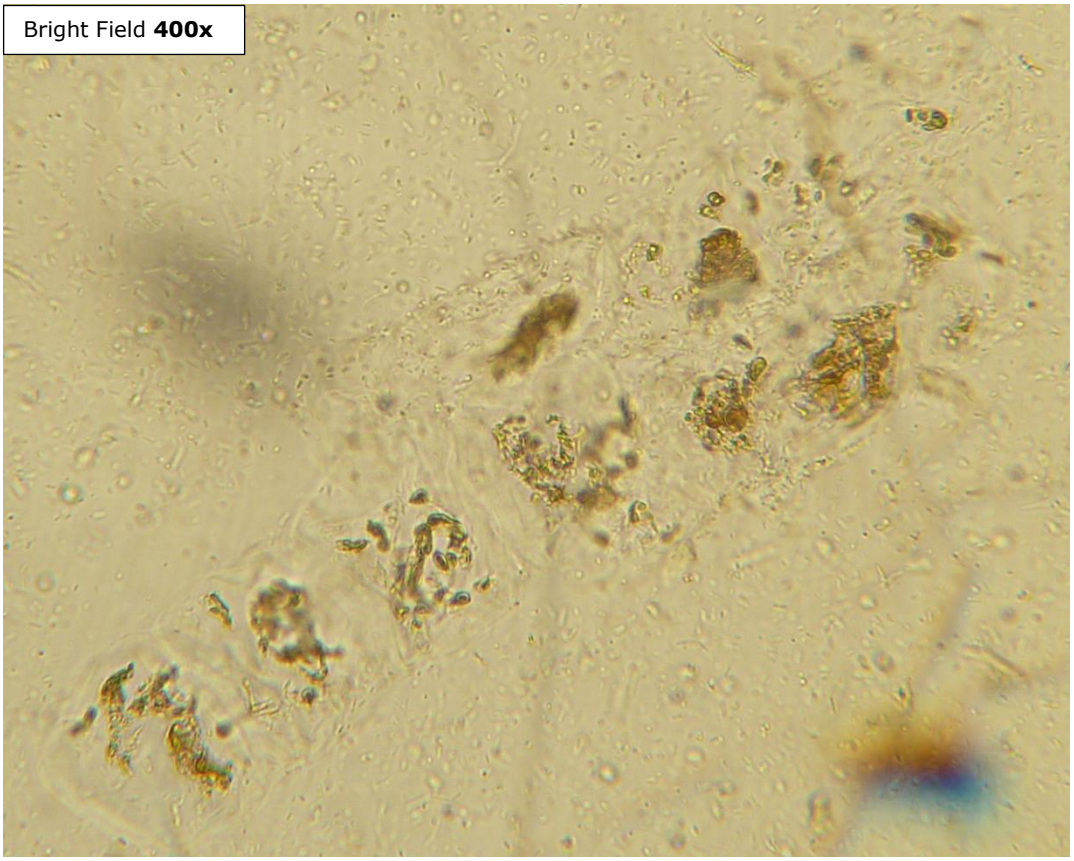


Phase Contrast **100x**

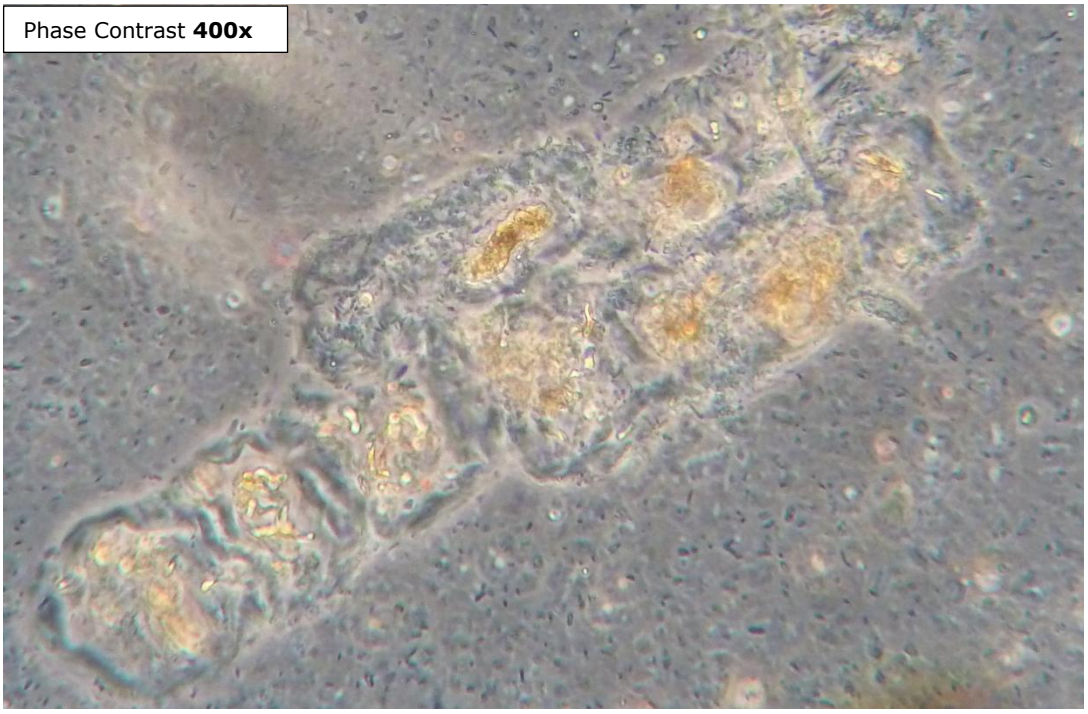


Contaminants in urine, fecal plant fibers:

Bright Field **400x**

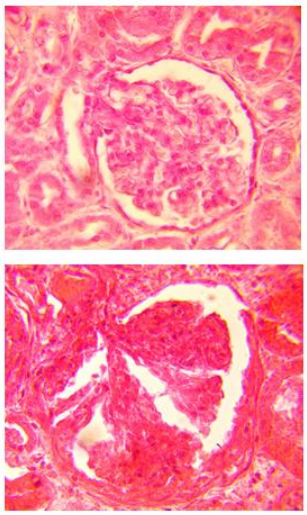


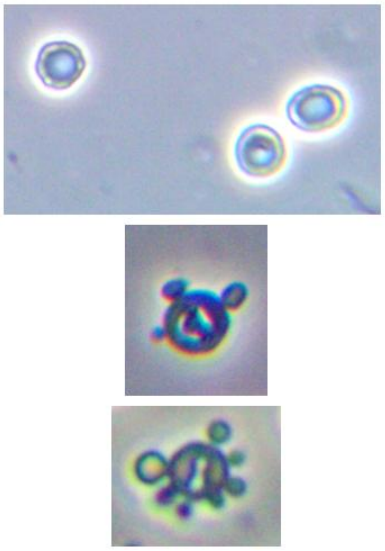
Phase Contrast **400x**



Chapter 2: Laboratory Diagnostics in Hematuria. (1, 2, 3, 4, 7, 10, 13)

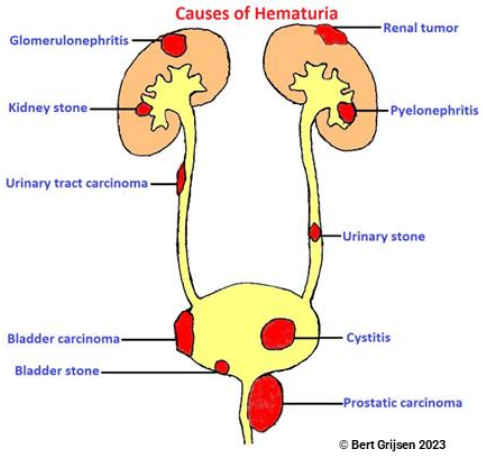
LABORATORY DIAGNOSTICS IN HEMATURIA





WHEN TO INVESTIGATE HEMATURIA?

- In patients with unexplained hematuria.
- Morphological assessment of erythrocytes and casts.
- Distinguish between glomerular/nephrological and non-glomerular/urological causes.



EXCLUDE POSSIBLE OTHER CAUSES:

- Period.
- Recent sexual activity.
- Intensive physical exertion.
- Recent urological interventions.

WHEN TO INVESTIGATE HEMATURIA?

Patient: red or dark urine: Cause nephrological or urological?

- Erythrocytes.
- Hemoglobin.
- Myoglobin (rhabdomyolysis).
- Food colorings: beetroot, rhubarb, berries.
- Medicines: Rifampicin.
- Toxic substances: lead, mercury.
- Metabolites: porphyria, alkaptonuria.

	Urine strip	Sediment	LD	CK
Erythrocytes	+	+	=	=
Hemoglobin	+	-	↑ of =	=
Myoglobin	+	-	↑	↑
Dyes	-	-	=	=

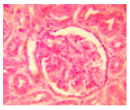
NEPHRON

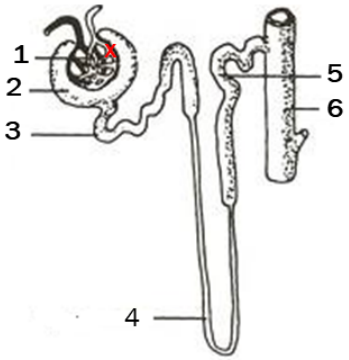
- Approximately 1 million nephrons per kidney.
- The glomerular membrane pore size ± 70 nm and neg charged podocytes.
- Permeability:
  -Maximum 70,000 (molecular weight albumin 66,000)
  -Particles < 40,000 or < 8 nm complete: salts, glucose, amino acids.
  -Particles neutral or + easy.
  -Negative proteins, most of them are not or difficult.
  -Cells don't.
  -Depending on the pressure.

1. Supplying and draining blood vessel
2. Bowman's capsule with GBM(X)
3. Tubulus contortus 1
4. Lis of Henle
5. Tubulus contortus 2
6. Collection tube to Pyelum

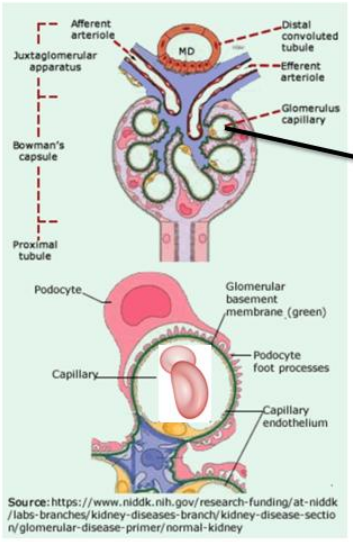
X: Glomerular Basement membrane.

Kidney biopsy glomerulus

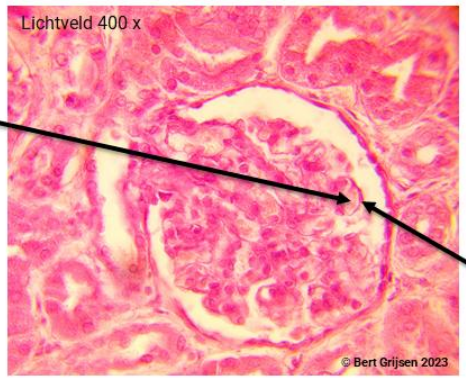


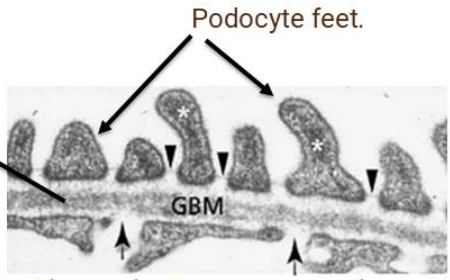


THE GLOMERULUS, TANGLE OF CAPILLARIES



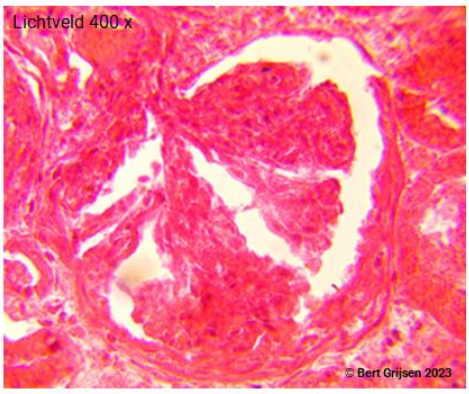
Kidney biopsy Glomerulus healthy kidney.

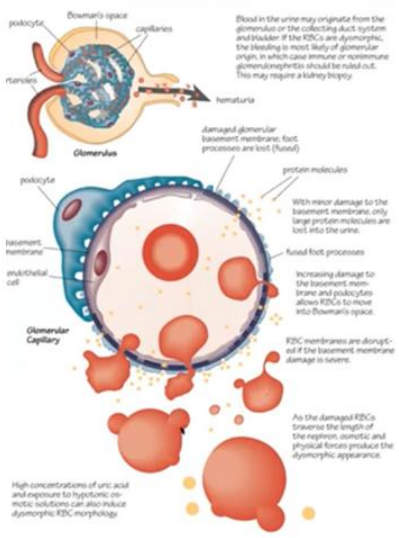




THE GLOMERULUS AND THE ORIGIN OF DYSMORPHIC ERYTHROCYTES

Kidney biopsy Glomerulus, obstructed kidney.



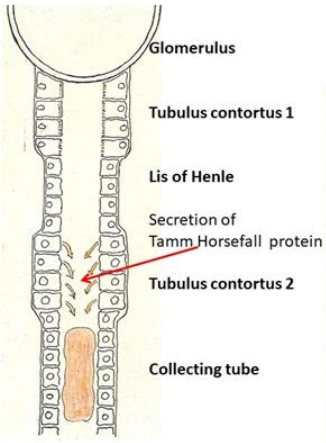


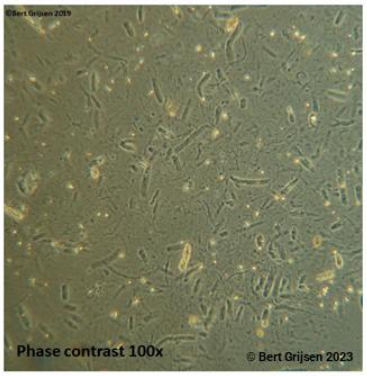
CASTS AND DYSMORPHIC ERYTHROCYTES IN URINE

- Due to increased intranephron pressure (reflux, obstruction).
- Due to acute cell necrosis of the glomerular membrane or tubule.
- Due to destruction of tubule cell wall by leucocytes.
- Due to reduced blood flow.

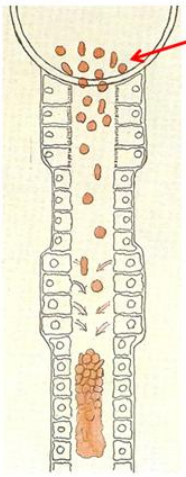
GLOMERULAR HEMATURIA AND THE FORMATION OF CASTS

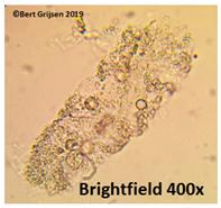
Base Cast: Hyaline





Erythrocyte Cast





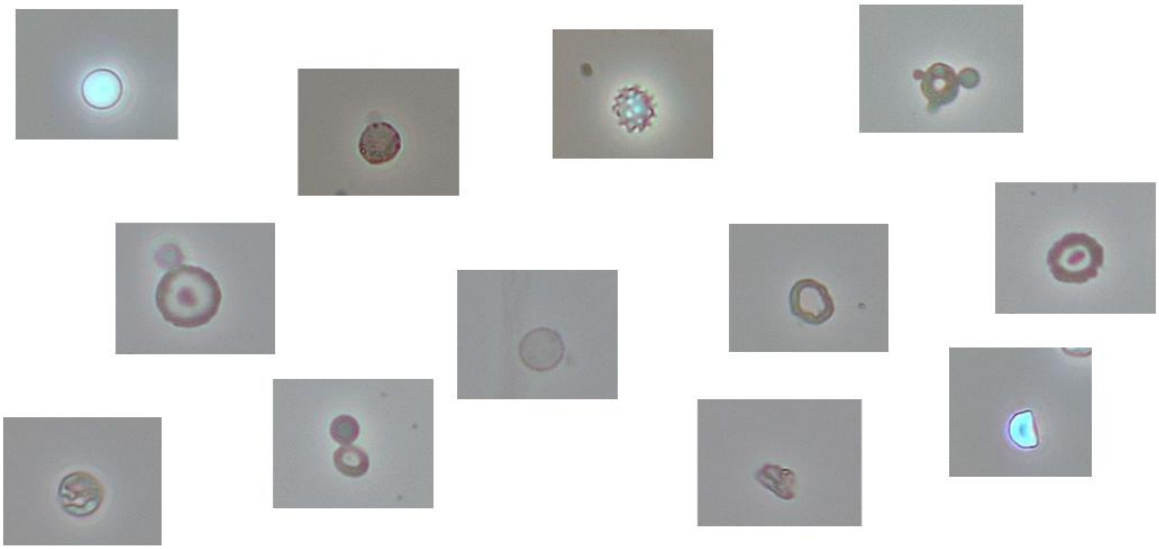
Clinical significance :
-Glomerular diseases
-Bacterial endocarditis
-Sepsis
- After substantial physical exertion

GLOMERULAR HEMATURIA VERSUS NON-GLOMERULAR

Glomerular Hematuria	Non Glomerular Hematuria
Leakage of erythrocytes into the glomerulus	**Bleeding in the draining urinary tract.**
Characteristics:	**Characteristics:**
-Polymorphic erythrocytes and dysmorphic >40%.	-Isomorfe erytrocyten.
-Erythrocyte casts (is indicative)	-No erythrocyte casts.
Causes (nephrological):	**Causes(urological):**
-Thin basement membranes.	-infection
-Glomerulonephritis.	-kidney stone
	-bleeding from renal cyst
	-trauma
	-polyp tumor

ASSESSMENT OF ERYTHROCYTES IN URINE ?

(ACCORDING TO THE FMS = FEDERATION OF MEDICAL SPECIALISTS)

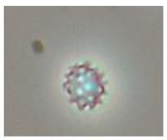


ERYTHROCYTES ISOMORPHIC

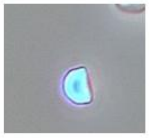
- Biconcave disc shape:

- "Ghosts", even outline:

- Osmotic changes,
  swollen or datura: echinocytes

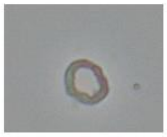


- "Bitten Cell" :



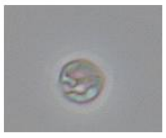
ERYTHROCYTES DYSMORPHIC

- Annular shape, bicycle tire/donut:



- Dense aggregates in cytoplasm:

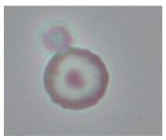
- Irregular Cytoplasm and/or Membrane:

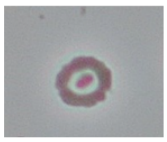


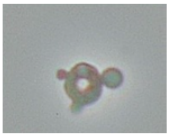
- Severely damaged by lysis or mechanical effects:

ERYTHROCYTES DYSMORPHIC: ACANTHOCYTES

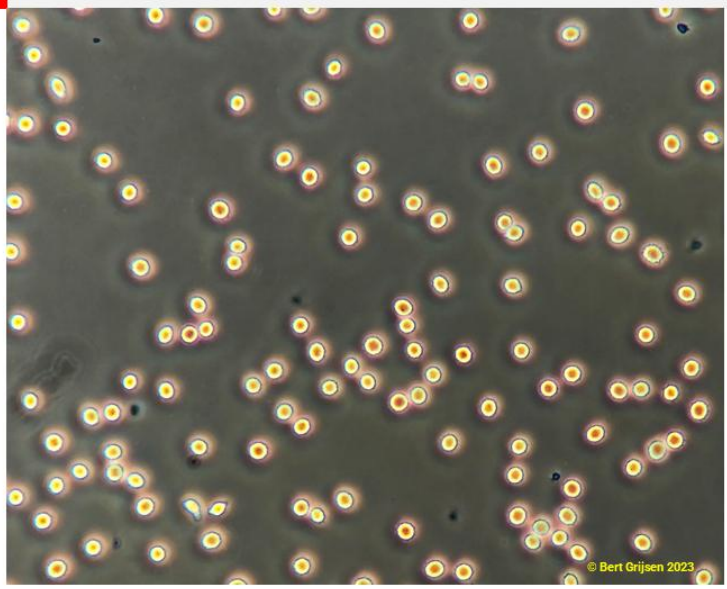
- Erythrocytes with vesicles/protrusions outwards or inwards: Mickey Mouse cells.
- More than 5%, specificity of 98% for glomerular hematuria.





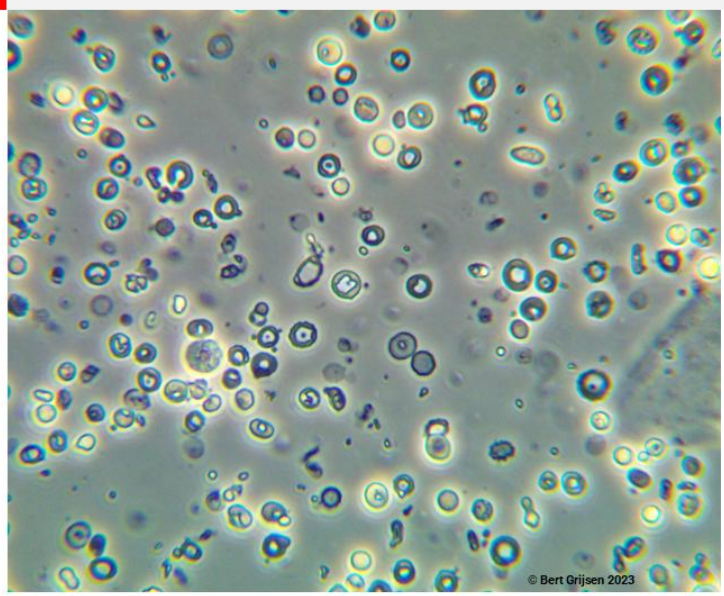


ERYTHROCYTES: ISOMORPHIC-DYSMORPHIC-ACANTHOCYTE?



Isomorphic

ERYTHROCYTES: ISOMORPHIC-DYSMORPHIC-ACANTHOCYTE?

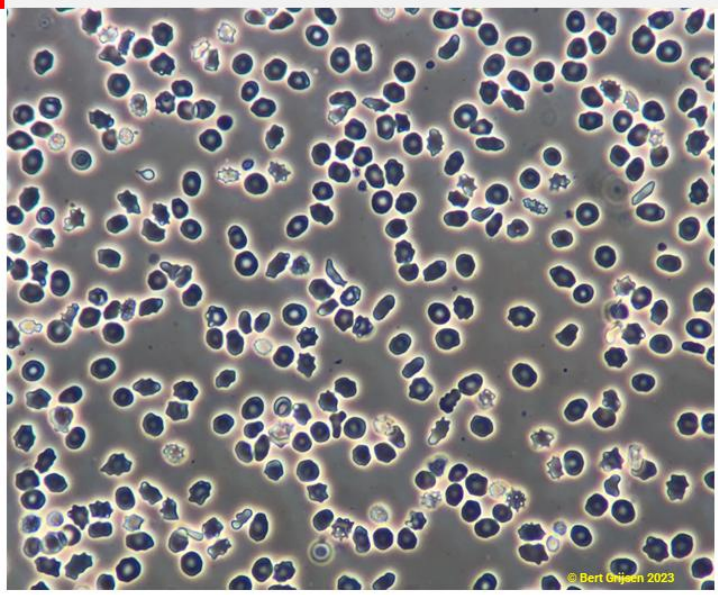


Male: 67 years old

Urine screen:
Protein: 0.2-0.5 g/l
pH: 5.0
Leuco: <10
Ery: >150
Nitrite: neg

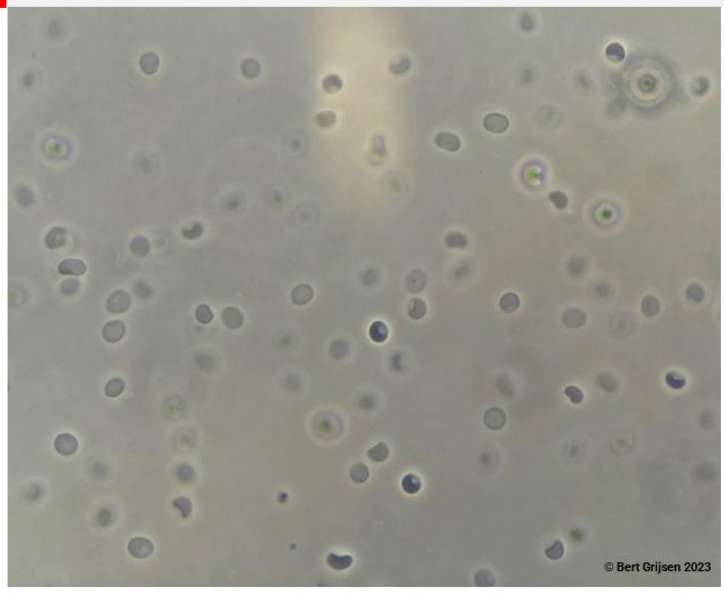
Sediment: Dysmorphic >40%
Acanthocytes >5%
Blood:
Kreat: from 141 to 167 µmol/l
Emergency ANCA 70.5 ↑↑↑ (<6.0)
Vasculitis?

ERYTHROCYTES: ISOMORPHIC-DYSMORPHIC-ACANTHOCYTE?



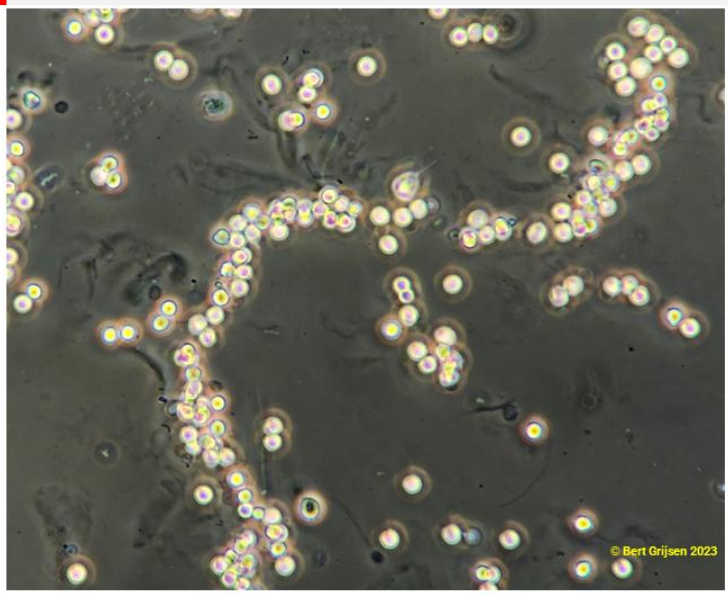
Isomorphic : Echinocytes (Hypertonic, high SG urine)

ERYTHROCYTES: ISOMORPHIC-DYSMORPHIC-ACANTHOCYTE?



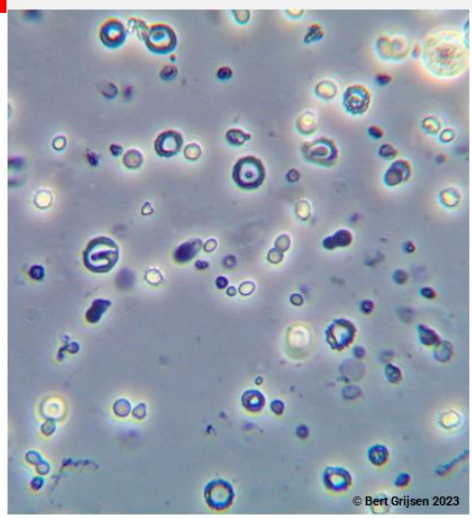
Isomorphic“Ghosts” (Hypotonic, low urine SG)

ERYTHROCYTES: ISOMORPHIC-DYSMORPHIC-ACANTHOCYTE?

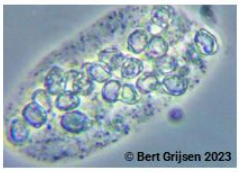


Isomorphic
Pseudocasts

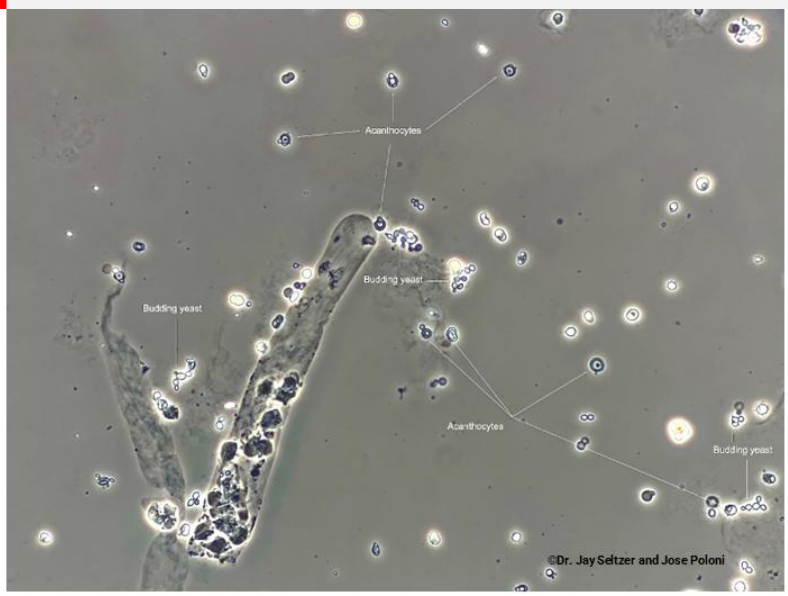
ERYTHROCYTES: ISOMORPHIC-DYSMORPHIC-ACANTHOCYTE?



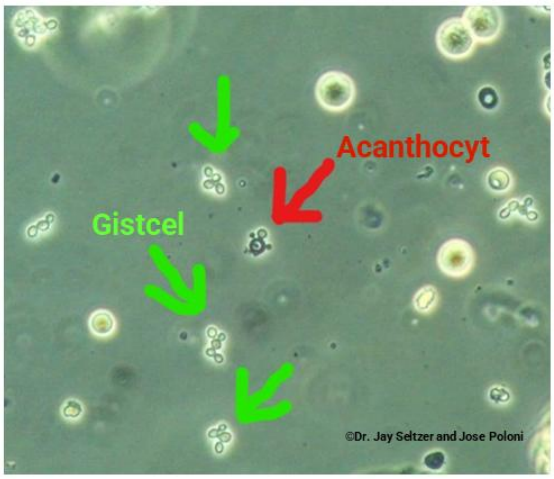
Male: 45 years old, Throat infection (Streptococcus?)
Dysmorphic >40% Acanthocytes >5% and Erythrocyte casts
Blood: Creatinine from 77 to 205 µmol/l



ERYTHROCYTES: ISOMORPHIC-DYSMORPHIC-ACANTHOCYTE?



Pitfall!!!
Acanthocytes and yeast cells



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REPORT HEMATURIA ACCORDING TO THE FMS AND UNILABS

%Dysmorphic erythrocytes	>5% acanthocytes and/or presence of erythrocyte casts	Conclusion
<40%	No	Glomerular hematuria unlikely
<40%	Yes	No clear distinction can be made between glomerular and non-glomerular hematuria, possible mixture.
>40%	No	Possible glomerular hematuria.
>40%	Yes	Probably glomerular hematuria.

THANKS TO:

Dr. R.G.H.J. Maatman Clinical Chemist ZGT/ MST/ RUG https://unilabs.nl

Prof. Dr. L.B. Hilbrands Nephrologist and Professor Radboudumc Nijmegen https://www.radboudumc.nl

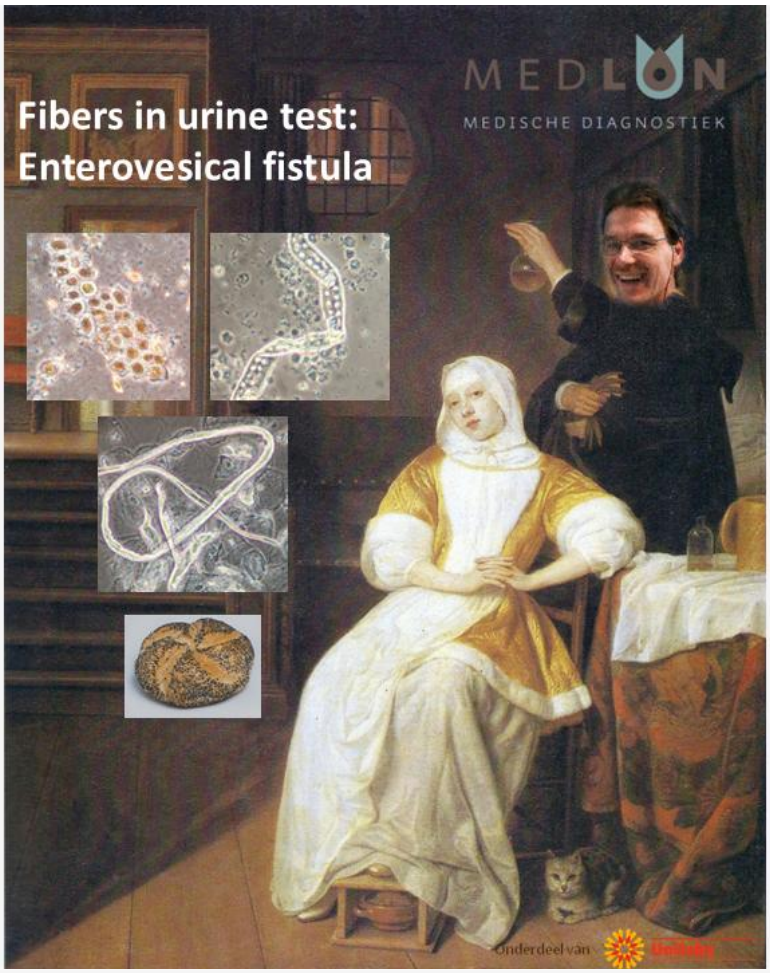
Dr. Jay R Seltzer, Nephrologist, Chief of Nephrology and Medical Director of Renal and Dialysis Services
Missouri Baptist Medical Center, Saint Louis Missouri USA https://www.missouribaptist.org
Renal fellow network https://www.renalfellow.org

NVML Nederlandse Vereniging van bioMedisch Laboratoriummedewerkers https://www.nvml.nl

HAN Hogeschool Arnhem Nijmegen https://www.han.nl
Cursus Morfologie van het Urinesediment – HAN

FMS Federation of Medical Specialists
Eenduidige en accurate laboratoriumdiagnostiek bij hematurie
Richtlijnendatabase FMS https://richtlijnendatabase.nl

Colleagues Laboratory Medlon, location ZGT Almelo https://www.medlon.nl



Why request fiber test?

- To detect a fistula (or pipe ulcer).
- A fistula is an unnatural channel.
- A connection between two body cavities or with the skin.

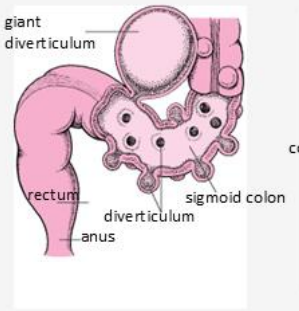
Cause:
- Congenital
- Inflammation (TB/amoeba/syphilis/diverticulitis)
- Tumor
- Trauma

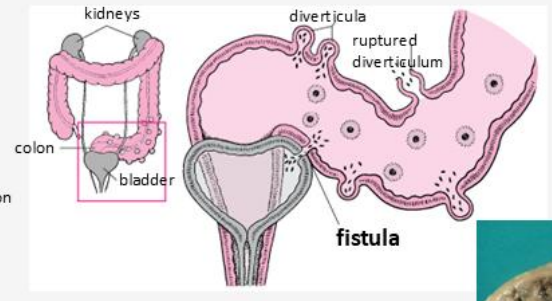
Different types of fistula:

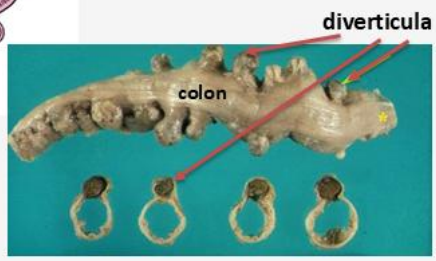
- Entero(recto)vesical fistula: connection between the intestine (rectum) and bladder.
- Enterocutaneous fistula: connection between the intestine and skin (perianal).
- Vesicovaginal fistula: connection between the bladder and vagina.
- Rectovaginal fistula: connection between the rectum and vagina.
- Ureteric fistula: ureterocutaneous, ureterovaginal, ureteroenteral.
- Tracheoesophageal fistula: connection (congenital) between the trachea and esophagus.

Cause entero(recto)-vesical fistula:

- **Bowel disorders:** - Colon cancer (20-30%)
  - Crohn's disease (chronic inflammation of the intestinal wall) (5-20%)
  - Diverticulitis (50-80%)







The formation of a fistula:

- Diverticulitis causes a perforation (opening) in the bladder wall.
- Difficult childbirth.
- Surgery or cesarean section.
- Radiation exposure (radiotherapy).
- Bladder stones, abscesses, or carcinomas.
- Occurs 3 to 5 times more often in men than in women:
  - The uterus between the bowel and bladder provides protection.

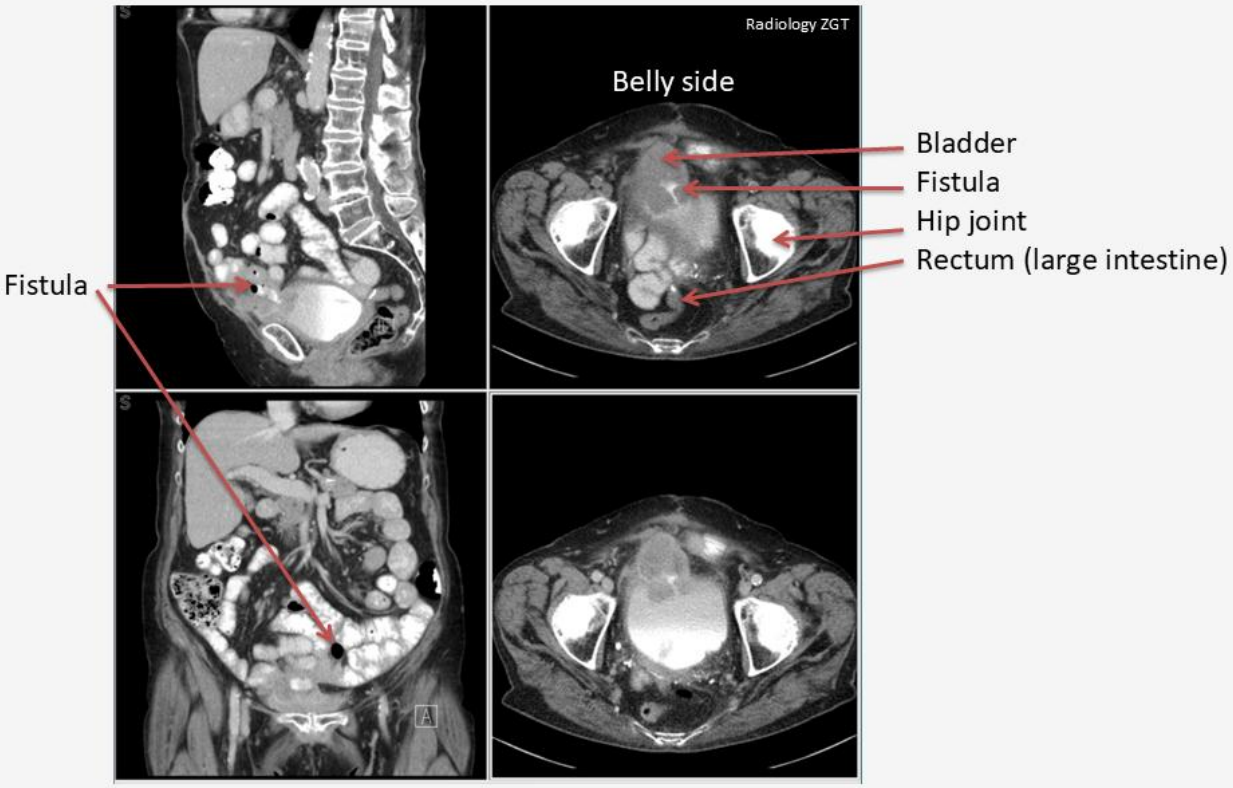
Patient complaints

- Bladder irritation:
  - frequent urination, small amounts
  - passing air (pneumaturia)
- Urinary tract infection:
  - feces and gas can enter the bladder
  - painful urination
  - foul-smelling urine (feces)
- Changes in bowel habits:
  - bloating
  - diarrhea
  - severe constipation

Additional Diagnostics:

- Cystoscopy (possibly with administration of methylene blue or contrast agent).
- Colon X-ray.
- Proctosigmoidoscopy.
- Abdominal CT scan.
- Urine examination for plant fibers.
- Urine examination for poppy seeds.

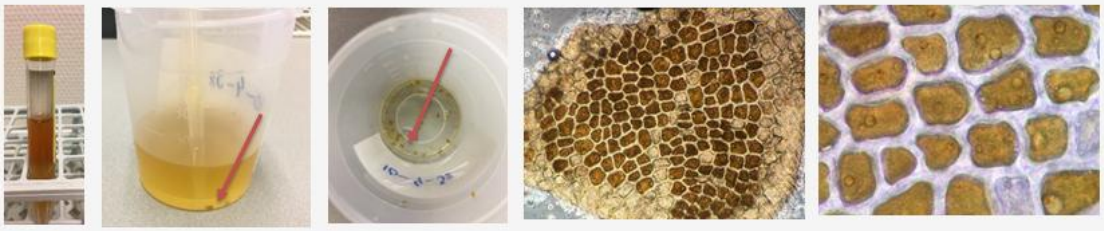
CT scans of the abdomen + barium:



Method:

- **Assess material macroscopically:**
  - Option 1: High density: Prepare a direct specimen, diluting if necessary.
  - Option 2: Particles at the bottom of the vial: Prepare a direct specimen.
  - Option 3: Material turbid or less concentrated: Centrifuge for 5 min at 2500 g and examinate the sediment.

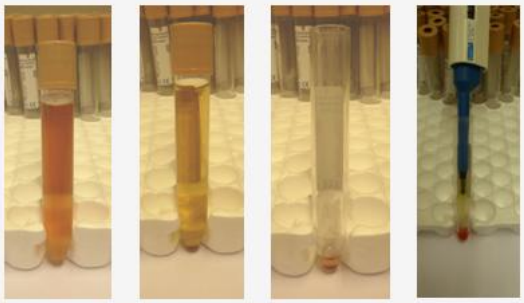
- **Evaluate the material at 100x magnification / phase contrast. -Minimum 15 images.**



Make sediment:

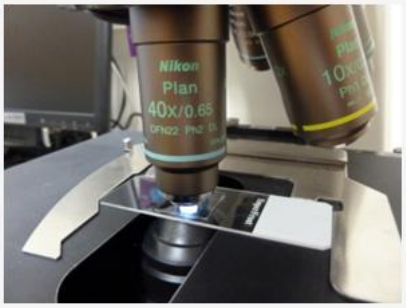
- Mix the urine well:

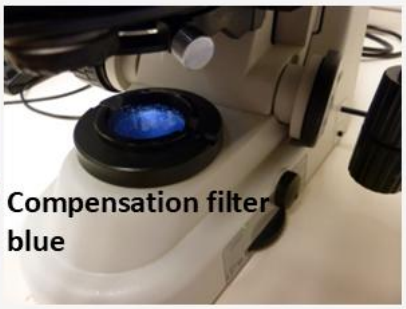
- Fill the tube with 9.5 ml of urine.
- Centrifuge for 5 min at 2500 g.
- Decant.
- Resuspend the sediment.
- Apply 15 µl of sediment.
- Use an 18 x 18 mm cover slip or, if necessary, a 24 x 32 mm cover slip.



Microscopic sediment examination:

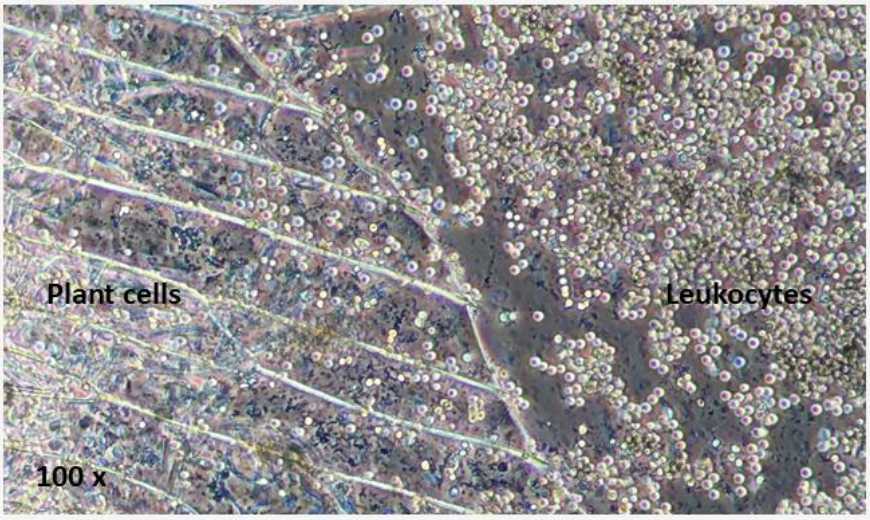
Use a microscope with phase contrast and possibly bright field.



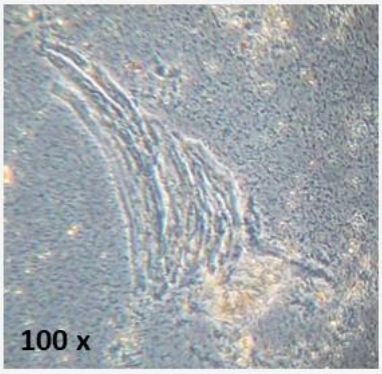


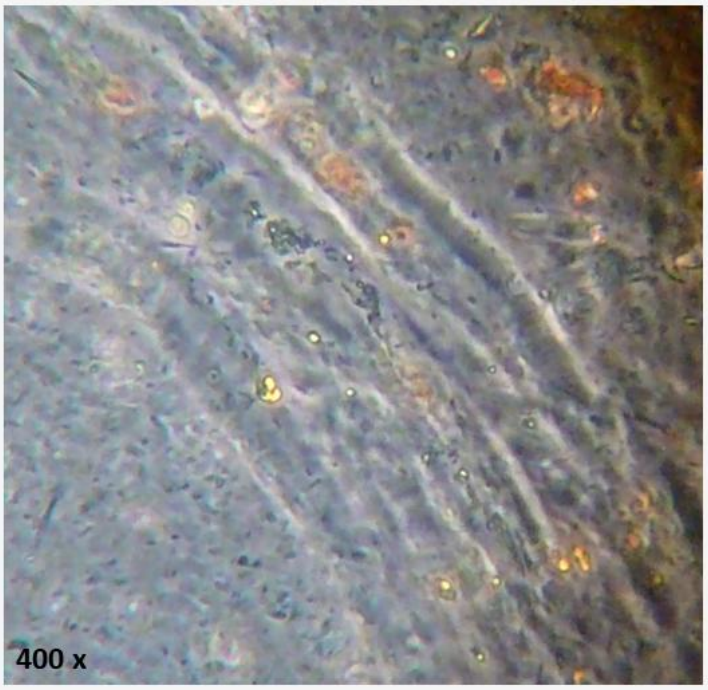
The detection of plant fibers:

- Relatively large: Plant fiber cannot pass through the kidney.
- Visible with 100x magnification.
- Plant cells have a membrane and a cell wall.
- Often highly refractive with phase contrast.



The detection of plant fibers:





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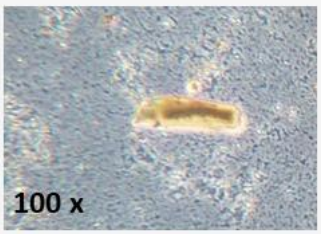

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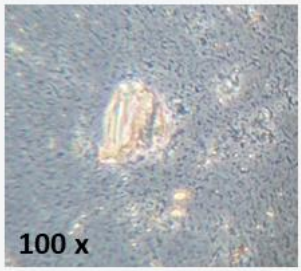

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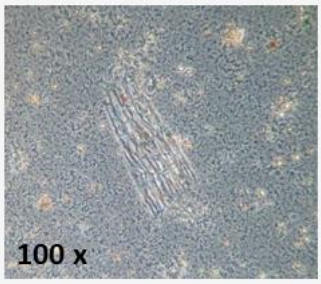

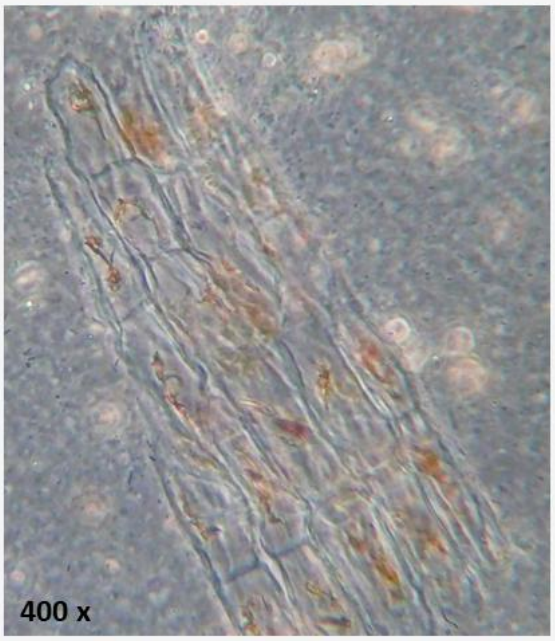

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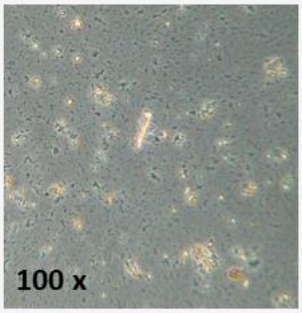

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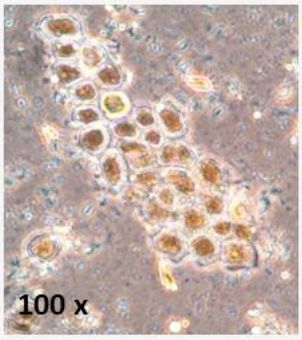

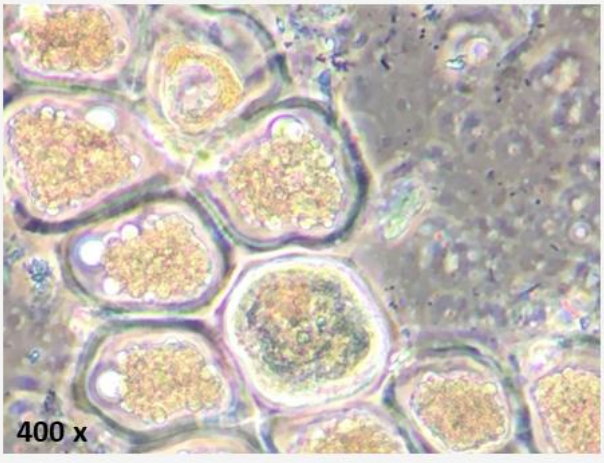

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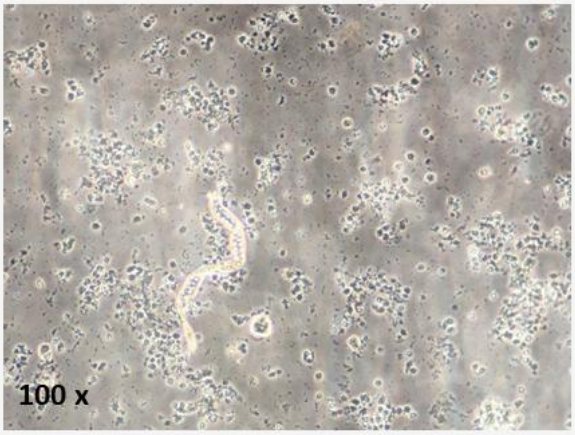

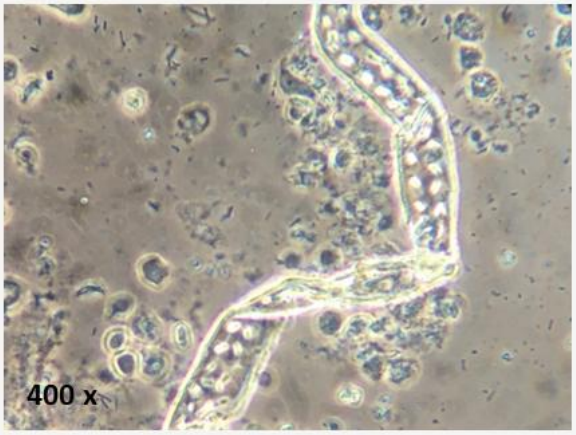

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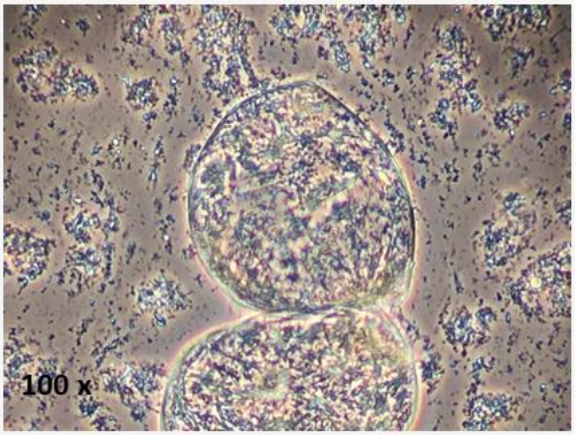

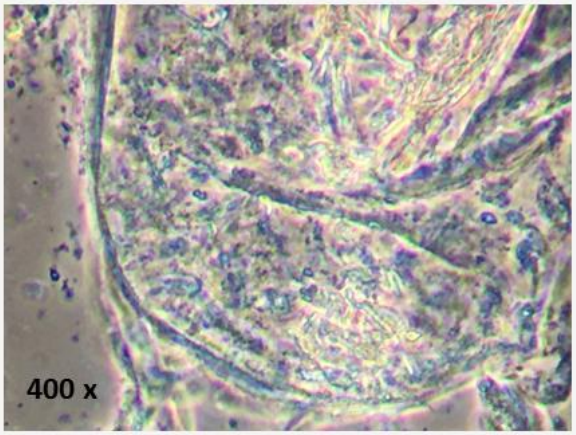

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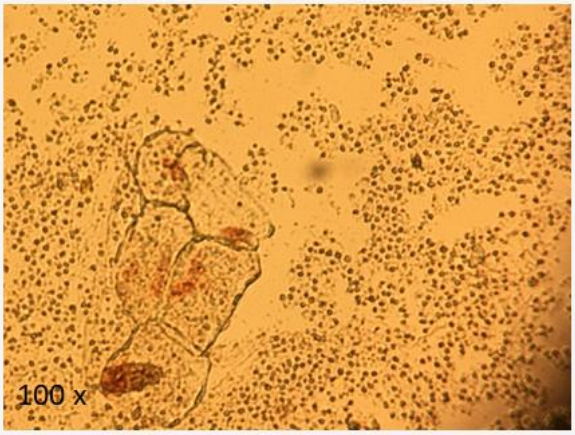

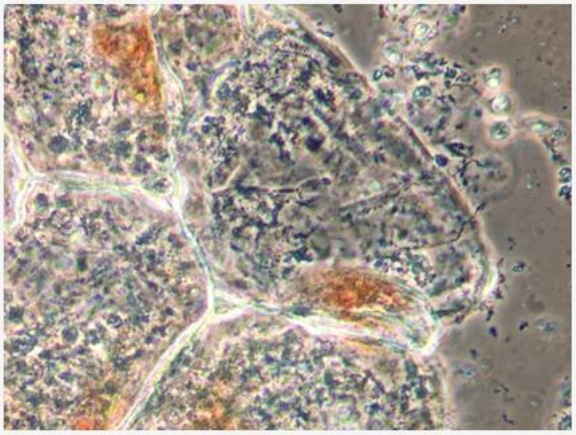

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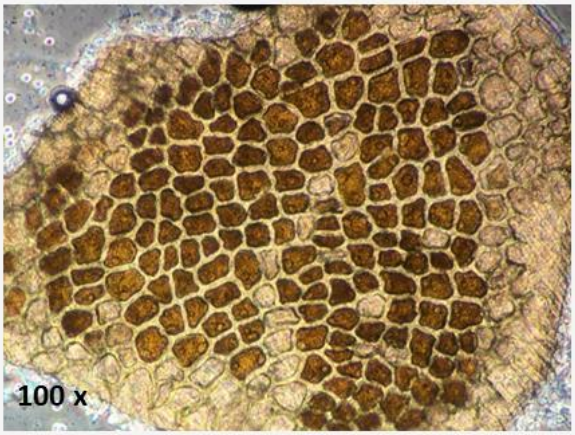

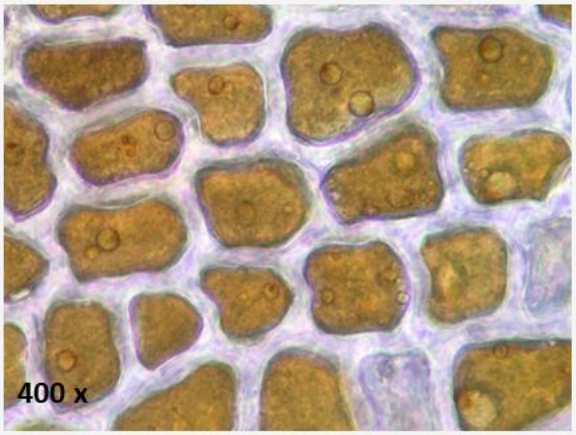

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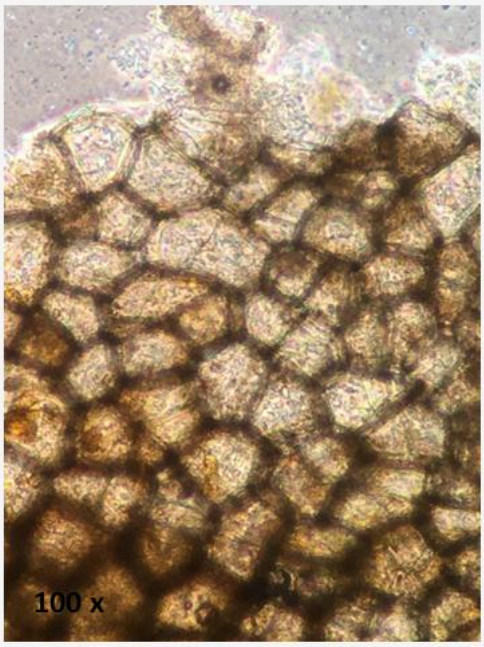
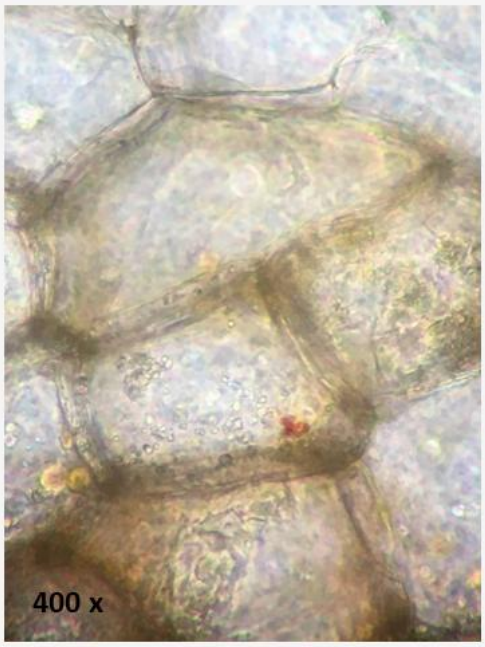
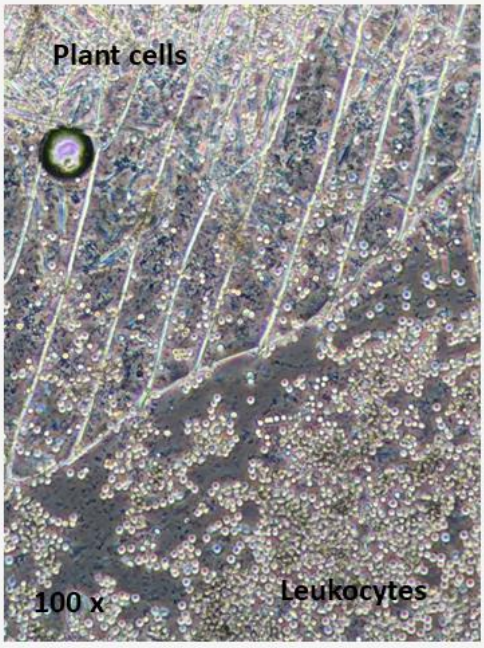


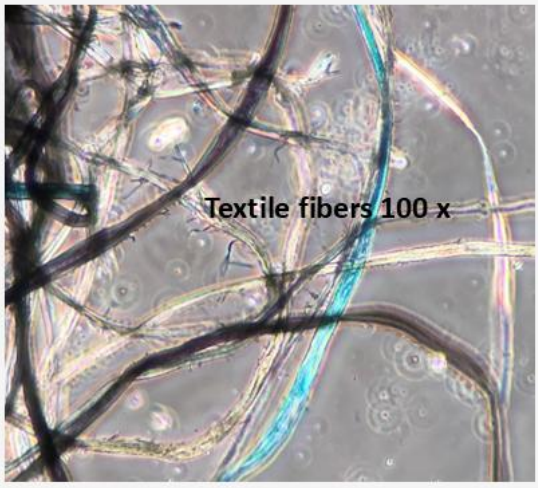


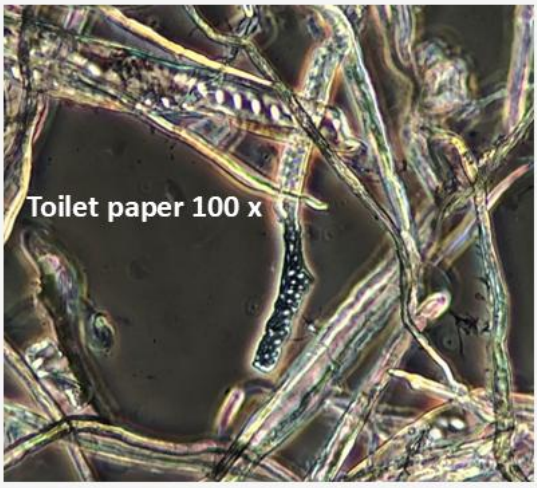
The detection of plant fibers:



Big pitfall fiber test!

- Textile fibers from underwear.
- Washed urine when cleaning with a cotton ball.
- Paper fibers from toilet paper.
- Contamination of feces with urine.





Plant fiber assessment:

- **Selection via control F:**

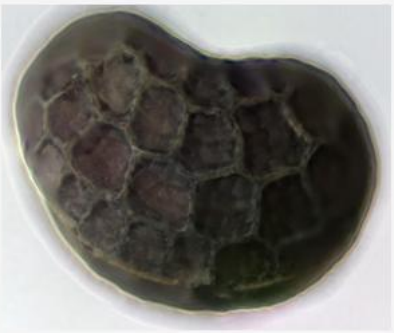
  - Negative: No fiber observed, with the comment, "Does the patient consume a high-fiber diet?"
  - Positive: Fiber present.

Alternative, the poppy seed test!

Simple test to detect entero-vesical fistula:

- Swallow a few grams of poppy seeds (one scoop is sufficient).
- Collect urine 24-48 hours after the procedure, depending on the presence of poppy seeds.
- Poppy seeds are visible macroscopically in the urine.

Poppy seed roll



Poppy seed microscopically

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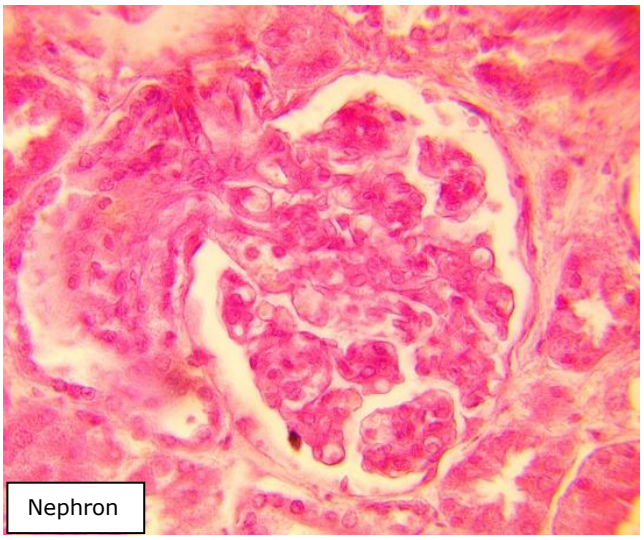
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