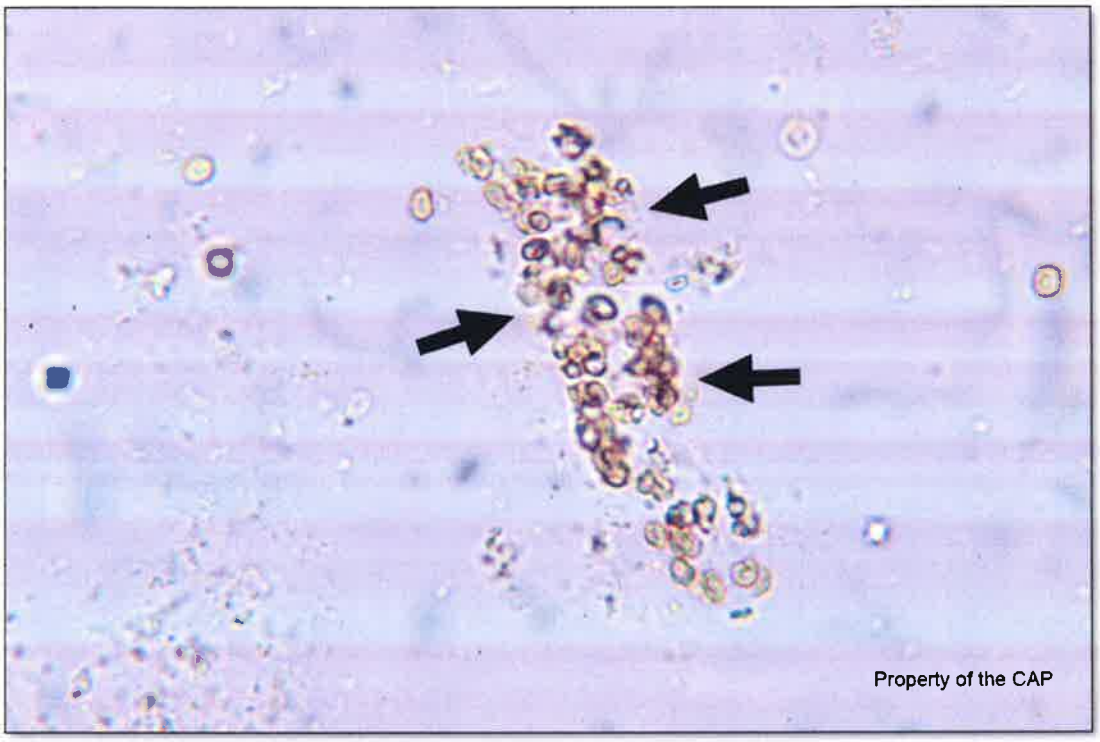
Urine Sediment Photographs

Case History CMP-13 through CMP-15

This urine sample is obtained from a 65-year-old man with known kidney disease. Laboratory data include: specific gravity = 1.026; pH = 7.0; blood 2+; protein 2+; and leukocyte esterase 1+; glucose, ketones, nitrite, bilirubin, and urobilinogen = negative. Identify the arrowed object(s) on each image.

(URINE, UNSTAINED, HIGH POWER)

CMP-13



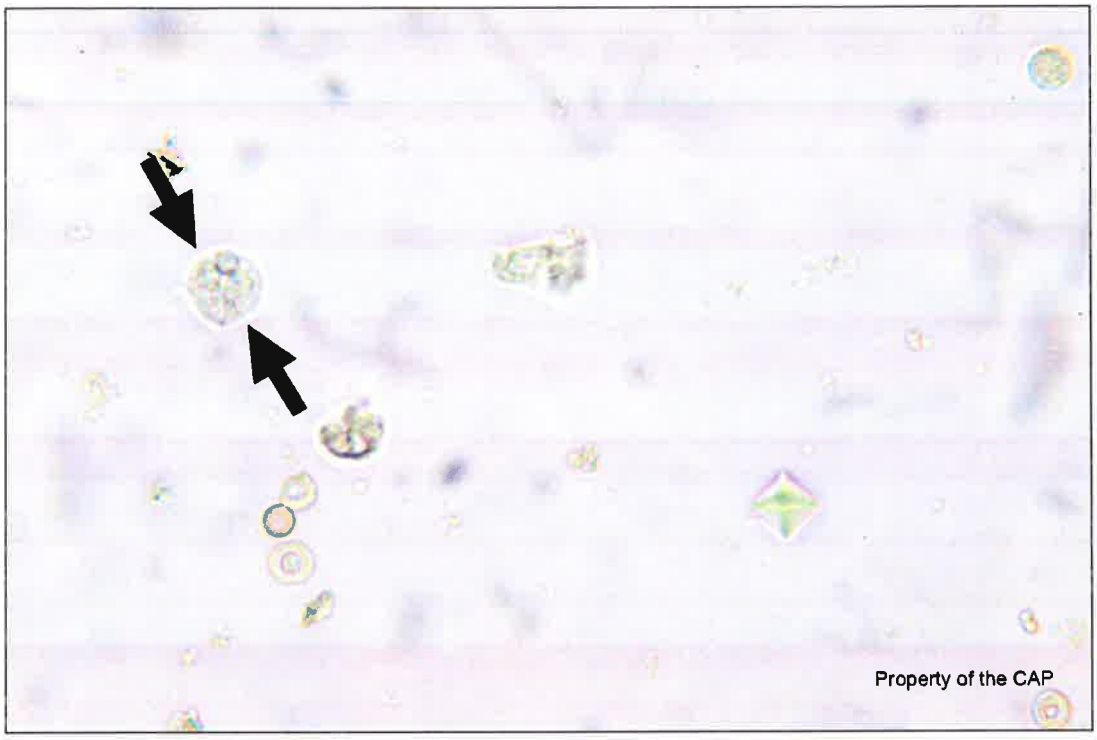
Identification	Participants		Evaluation
	No.	%	
RBC/muddy brown cast	5988	97.2	Good
Cellular cast (neutrophil and/or RTE)	97	1.6	Unacceptable

The arrowed element is an RBC cast, as correctly identified by 97.2% of participants. The RBC cast in this unstained wet prep is identified by the present of intact red blood cells of uniform size loosely contained within the hyaline matrix of the cast. The red blood cells are somewhat shrunken and crenated when compared with the free erythrocytes in the surrounding urine. Red blood cell casts are of clinical importance because they are associated with nephritis, glomerular injury, or acute tubular necrosis.

The arrowed element was incorrectly identified by 1.6% of participants as a cellular cast (neutrophil). The cells in the cast lack a nucleus, are orange, and are no larger than the surrounding red blood cells, therefore identifying them as red blood cells and excluding the possibility of larger nucleated cells such as neutrophils or renal tubule epithelial cells.

Urine Sediment Photographs

CMP-14



Identification	Participants		Evaluation
	No.	%	
Leukocyte (neutrophil, eosinophil, lymphocyte)	5523	89.7	Good
Renal tubular epithelial (RTE) cell	138	2.2	Unacceptable
Fat droplet	90	1.5	Unacceptable

The arrowed cell is a leukocyte, as correctly identified by 89.7% of participants. The white blood cell in this unstained wet preparation is identified as a granular round cell approximately 10 µm, slightly less than twice the size of the red cells also appearing in this image. Granular cytoplasm can be appreciated but nuclear detail is not apparent. This dense granular appearance is common for white blood cells, particularly in urine that is hypertonic or not fresh. Increased numbers of leukocytes in the urine is termed pyuria and is associated with inflammation in the urinary tract such as infection or other kidney disease. A few neutrophils may be found in the urine of normal patients.

The arrowed object was incorrectly identified by 2.2% of participants as a renal tubular epithelial cell (RTE). RTEs are larger than leukocytes, 15 - 35 µm or 2 - 5x the size of an RBC. The cell shape can vary from round to oval to polyhedral and elongated. Elongated RTE cells have typically round nuclei that may be eccentrically located toward the basilar regions of these cells. Proximal and distal tubule RTEs can be round, oval or polygonal. Those from the proximal tubule may also have a flat edge where the apical microvillus boarder is located. Collecting duct RTEs are usually columnar but can be cuboidal or

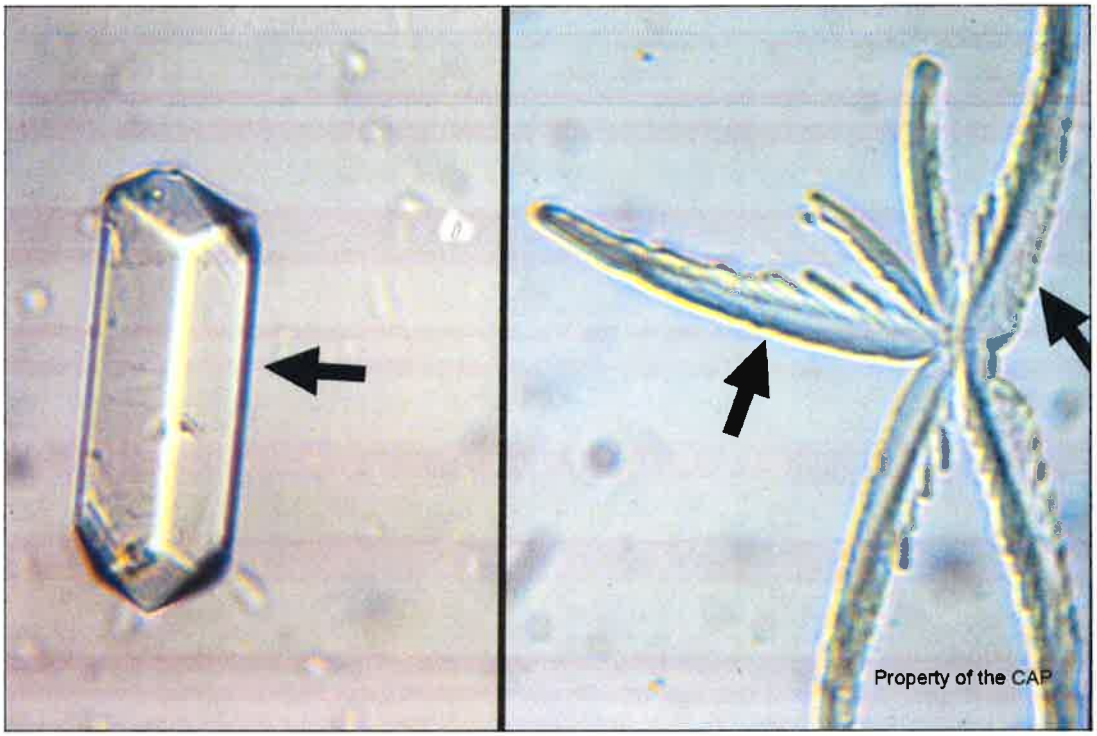
polygonal. The cytoplasm is typically more granular than a transitional epithelial cell but less granular than a neutrophil. Degenerative changes include fraying of the cytoplasm, leaving indistinct cell borders.

RTEs can develop distinctive morphologies in certain conditions. In nephrosis or lipiduria, they resorb lipids and become oval fat bodies. These resorbed lipid droplets will exhibit a "Maltese cross" pattern under polarized light. RTEs infected by viruses may have nuclear or cytoplasmic inclusions, best appreciated on stained preparations. RTE cytoplasm can be stained with pigments such as bile and hemosiderin.

The arrowed object was incorrectly identified by 1.5% of participants as a fat droplet. Fat droplets can be identified by their round shape and variable size. The droplets may be dark under low power, but usually are clear at high power. The droplets are refractile, show a Maltese-cross pattern under polarized light, and will stain positively with fat stains such as Sudan black. Fat droplets are often seen with fatty casts, and like the casts are associated with the nephrotic syndrome. Fat droplets can also be seen with contamination from oils or topical creams.

Urine Sediment Photographs

CMP-15



Identification	Participants		Evaluation
	No.	%	
Ammonium magnesium (triple) phosphate	5992	97.9	Good
Hippuric acid crystals	68	1.1	Unacceptable

The arrowed elements are ammonium magnesium (triple) phosphate crystal as correctly identified by 97.9% of participants. These triple phosphate crystals are identified by the classic "coffin-lid" 5-sided prism shape in the left pane and the "feathery" appearance in the right pane. These crystals are common but can be associated with struvite stones caused by urease-positive bacteria and alkaline urine. Often these triple phosphate crystals are accompanied by amorphous phosphates and bacteria. They are birefringent in polarized light.

The arrowed elements was incorrectly identified by 1.1% of participants as a hippuric acid crystals. Although hippuric acid crystal prisms with beveled edges can resemble small triple phosphate crystals, they never take the feathery, star-like, or leaf-like form shown in this image. Unlike triple phosphate crystals, hippuric acid crystals typically take flat rhombic plate forms and needle forms. They are typically found in persons who eat a diet rich in benzoic acid, such as one rich in certain vegetables, but they may also be seen in patients with acute febrile illnesses or liver disease.

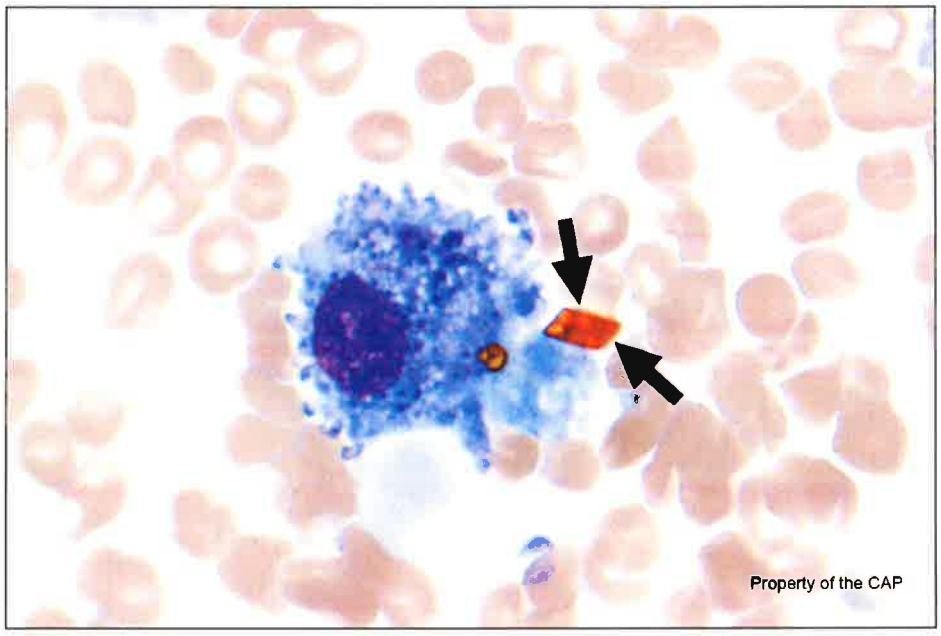
Body Fluid Photographs

Case History CMP-16 through CMP-18

This patient is a 68-year-old woman being seen in the emergency room for a brain hemorrhage. Cerebrospinal fluid sample laboratory findings include: WBC = 10,000/µL (10.000 x 10E3/µL); RBC = 65/µL (0.065 x 10E3/µL). Identify the arrowed object(s) on each image.

(CSF, CYTOCENTRIFUGE, WRIGHT-GIEMSA, 100X)

CMP-16



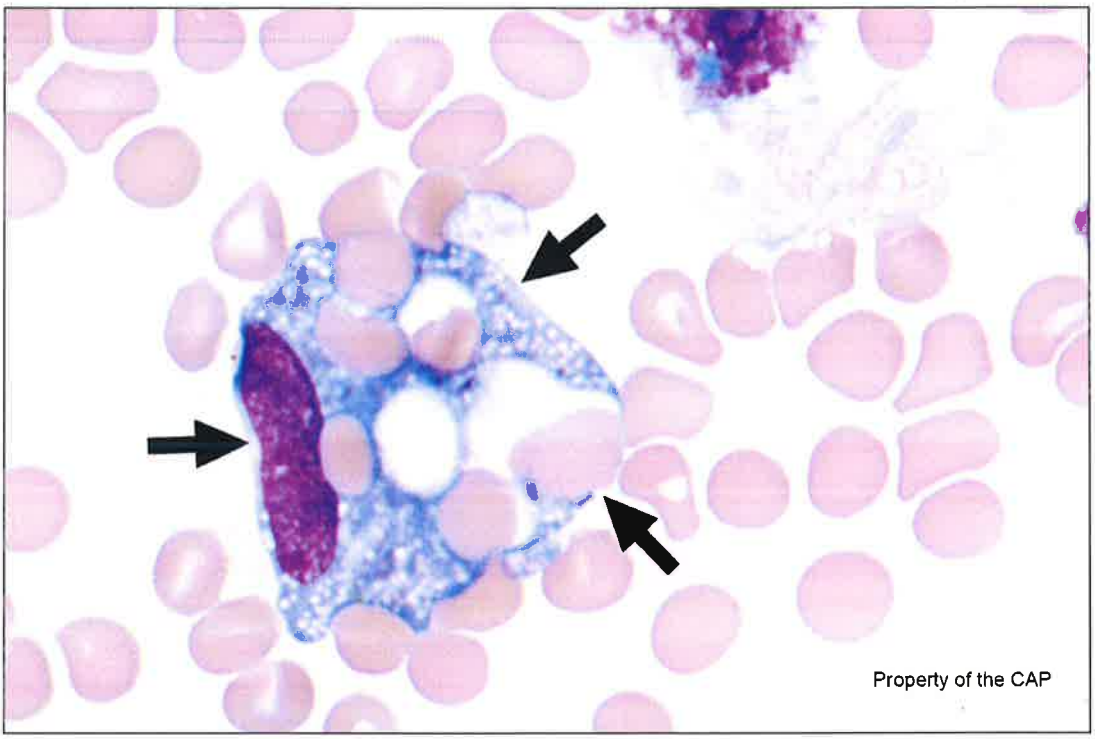
Identification	Participants		Evaluation
	No.	%	
Hematin/hematoidin crystal	3759	95.2	Good
Calcium pyrophosphate dihydrate (CPPD) crystal	53	1.3	Unacceptable

The arrowed object is a hematin/hematoidin crystal as correctly identified by 95.2% of the participants. Hematin and hematoidin crystals both result from the breakdown of hemoglobin in tissue. Hematin is a porphyrin compound. Hematoidin is similar to bilirubin. The crystals may be found anywhere in the body after bleeding/hemorrhage. The crystal may be either intra- or extracellular (as depicted in the image). The crystals are bright yellow and have a rhomboid shape. They do not stain with iron stains.

1.3% of the participants incorrectly identified the arrowed object as a calcium pyrophosphate dihydrate (CPPD) crystal. These crystals are found in the synovial fluid of patients with arthritis, pseudogout, or associated with other metabolic diseases (such as hypothyroidism). CPPD crystals are intracellular, usually 1 - 20 um long, and rod-shaped, rhomboid, diamond, or square. They can be differentiated from monosodium urate crystals by polarizing microscopy with a first-order red compensator. The CPPD crystals are blue when the long axis of the crystal is parallel to the slow ray of light from the color compensator (positive birefringence); MSU crystals are yellow (negative birefringence).

Body Fluid Photographs

CMP-17



Identification	Participants		Evaluation
	No.	%	
Macrophage containing erythrocyte(s) (Erythrophage)	3767	95.3	Good
Macrophage containing abundant uniform small lipid vacuoles/ droplets (Lipophage)	69	1.8	Unacceptable
Monocyte/macrophage	68	1.7	Unacceptable

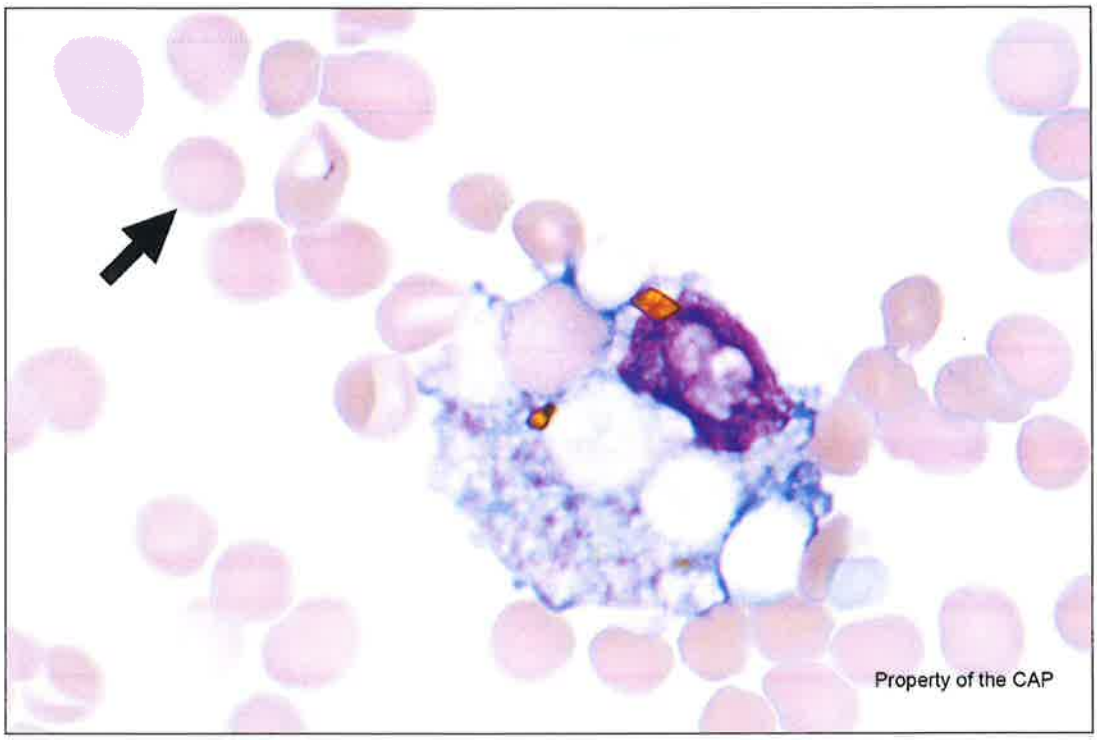
The arrowed cell is a macrophage containing erythrocytes (erythrophage) as correctly identified by 95.3% of the participants. The erythrophage is a macrophage that has ingested red blood cells, usually due to hemorrhage from trauma or a bleeding disorder. As phagocytic activity may persist following the acquisition of the specimen, the presence of erythrophagocytosis does not always imply in vivo erythrophagocytosis. However, it can be an important clue to prior hemorrhage.

1.8% of the participants incorrectly identified the arrowed cell as a macrophage containing abundant uniform small lipid vacuoles/droplets (lipophage). The lipophage is a macrophage containing small uniform, lipid vacuoles that completely fill the cytoplasm. These fat-filled inclusions may originate from extracellular fatty material or from the membranes of ingested cells. Lipophages may be present in CSF following cerebral infarcts, injections of intrathecal chemotherapy, or post-irradiation. They may be present in pleural fluid associated with chylothorax or with extensive cell membrane destruction.

1.7% of the participants incorrectly identified the arrowed cells as a monocyte/macrophage. While the arrowed cell is a macrophage, the answer is incomplete, since a macrophage containing erythrocytes (erythrophage) is a specific cell, which can be an important clue to prior hemorrhage (see above).

Body Fluid Photographs

CMP-18



Identification	Participants		Evaluation
	No.	%	
Erythrocyte	3920	99.2	Good

The arrowed cell is an erythrocyte as correctly identified by 99.2% of the participants. These are typical erythrocytes without nuclei and similar to those present in the peripheral blood. They are not typically found in normal body fluid samples and reflect hemorrhage or traumatic contamination.

Clinical Presentation:
This patient is a 68-year-old woman being seen in the emergency room for a brain hemorrhage. Cerebrospinal fluid sample laboratory findings include: WBC = 10,000/µL (10.000 × 10E3/µL); RBC = 65/µL (0.065 × 10E3/µL).

(CSF, CYTOCENTRIFUGE, WRIGHT-GIEMSA, 100X)

CASE DISCUSSION: Cerebral bleed/hemorrhage
Twenty percent of strokes are hemorrhagic, with subarachnoid hemorrhage (SAH) and intracerebral hemorrhage (ICH), each accounting for 10%. The hemorrhage may be categorized as either spontaneous (atraumatic) or traumatic (post-injury). The most common cause of atraumatic SAH is spontaneous rupture of an aneurism, which is often a devastating clinical event with substantial mortality and high morbidity among survivors.

The overall incidence of spontaneous ICH ranges from 12 to 31 per 100,000 people and varies by race, and the overall incidence of aneurismal SAH is 7.9 per 100,000 people. The incidence of ICH increases with age, doubling every 10 years after age 35, while SAH can occur at any age with most cases occurring between 40 and 60 years of age.

The most common risk factors associated with either ICH or SAH are hypertension, smoking, anti-thrombotic medications, trauma, bleeding diatheses, amyloid angiopathy, illicit drug use (mostly amphetamines and cocaine), vascular malformations, and family history. Many risk factors for aneurysmal SAH are modifiable.

The classic presentation of patients with aneurysmal SAH is a sudden-onset, severe headache typically described as the "worst headache of my life". Every patient with this kind of headache should be evaluated for SAH. Headache is often an isolated finding; however, it could be associated with a brief loss of consciousness, vomiting, and neck pain or stiffness. Meningismus, often accompanied by lower back pain, may develop several hours after the bleed, since they are caused by the breakdown of blood products within the cerebrospinal fluid (CSF), which lead to an aseptic meningitis. While many patients have an altered level of consciousness, coma is unusual. The signs and symptoms of ICH vary according to the location and size of the hemorrhage. The most common presenting complaints are headache and vomiting, occurring in approximately one-half of the patients. Large hemorrhage is associated with a decreased level of consciousness, with some patients discovered obtunded or comatose.

The diagnostic approaches to ICH and SAH are different. For patients with ICH, computed tomography (CT) or magnetic resonance imaging (MRI) are considered first-choice imaging options for the emergency diagnosis and assessment with CSF examination playing a minimal diagnostic role. On the other hand, the diagnosis of SAH is based on non-contrast CT and lumbar puncture findings. If both tests are negative, they effectively eliminate the diagnosis of SAH as long as both tests are performed within two weeks of the presenting symptoms. LP should include measurement of opening pressure, routine CSF analyses including red blood cell (RBC) and white blood cell counts, and visual inspection for xanthochromia. The classic lumbar puncture findings of SAH are an elevated opening pressure, an elevated RBC count that does not diminish from CSF tube 1 to tube 4, and xanthochromia. The stained CSF smears/cytospins demonstrate macrophages containing RBCs (erythrophages) that start appearing in CSF approximately 2 hours after the bleeding. As the RBCs start to degenerate, the CSF smears show

their breakdown products in a form of macrophages containing hemosiderin (siderophages) or yellow crystalline iron-free hematin/hematoidin crystals. The formation of these hemosiderin deposits and hematoidin crystals occurs approximately 18 hours following a subarachnoid hemorrhage. The hemosiderin deposits, hematoidin crystals, and siderophages may be present in the CSF for several months.

Once a diagnosis of SAH or ICH has been made, the etiology of the hemorrhage must be determined with vascular imaging to help guide preventive measures to reduce the risk of recurrent hemorrhage.

Olga Pozdnyakova, MD, PhD, FCAP
Catalina Amador, MD, FCAP
Hematology and Clinical Microscopy Committee

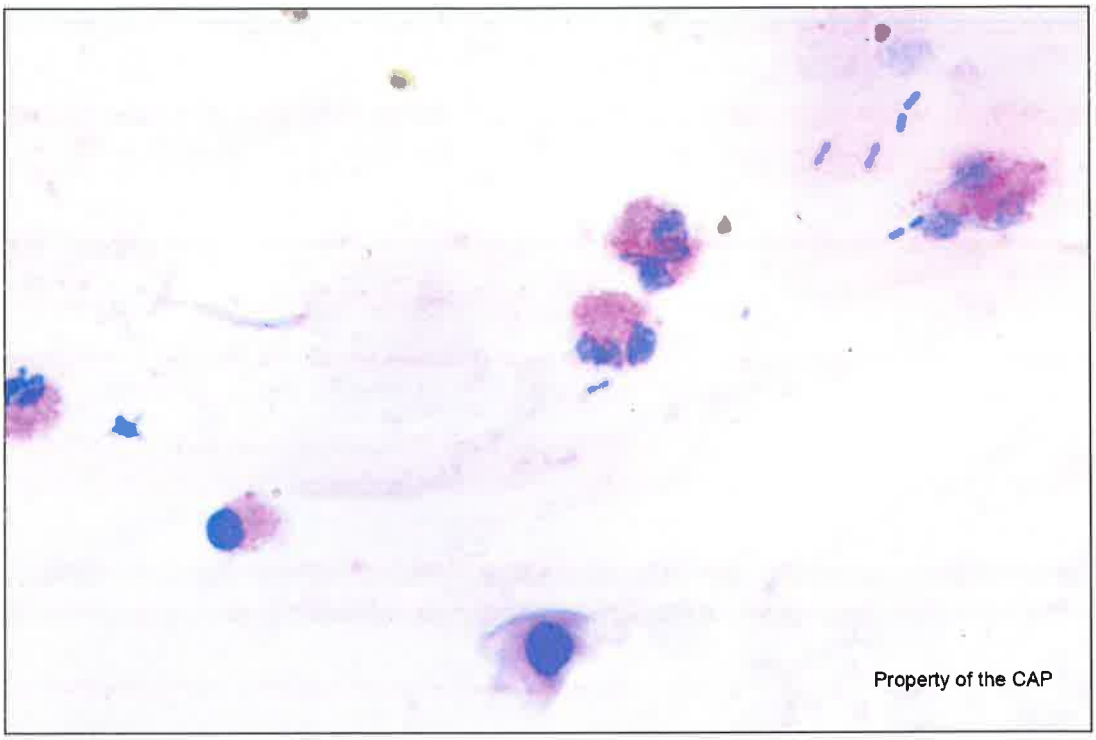
References:

1. Galagan KA, Blomberg D, Cornbleet PJ, Glassy EF, eds. *Color Atlas of Body Fluids: An Illustrated Field Guide Based on Proficiency Testing*. 1st ed. College of American Pathologists; 2006.
2. Rordorf G, McDonald C, Goddeau, RP, ed. *Spontaneous intracerebral hemorrhage: Pathogenesis, clinical features, and diagnosis.* In: UpToDate. 2021.
3. Singer RJ, Ogilvy CS, Rordorf G, Goddeau, RP, ed. *Aneurysmal subarachnoid hemorrhage: Clinical manifestations and diagnosis.* In: UpToDate. 2021.

CMMP – Clinical Microscopy Miscellaneous Photographs

(NASAL, WRIGHT-GIEMSA)

CMMP-32



Identification	Participants		Evaluation
	No.	%	
Eosinophils are present	1966	97.7	Good

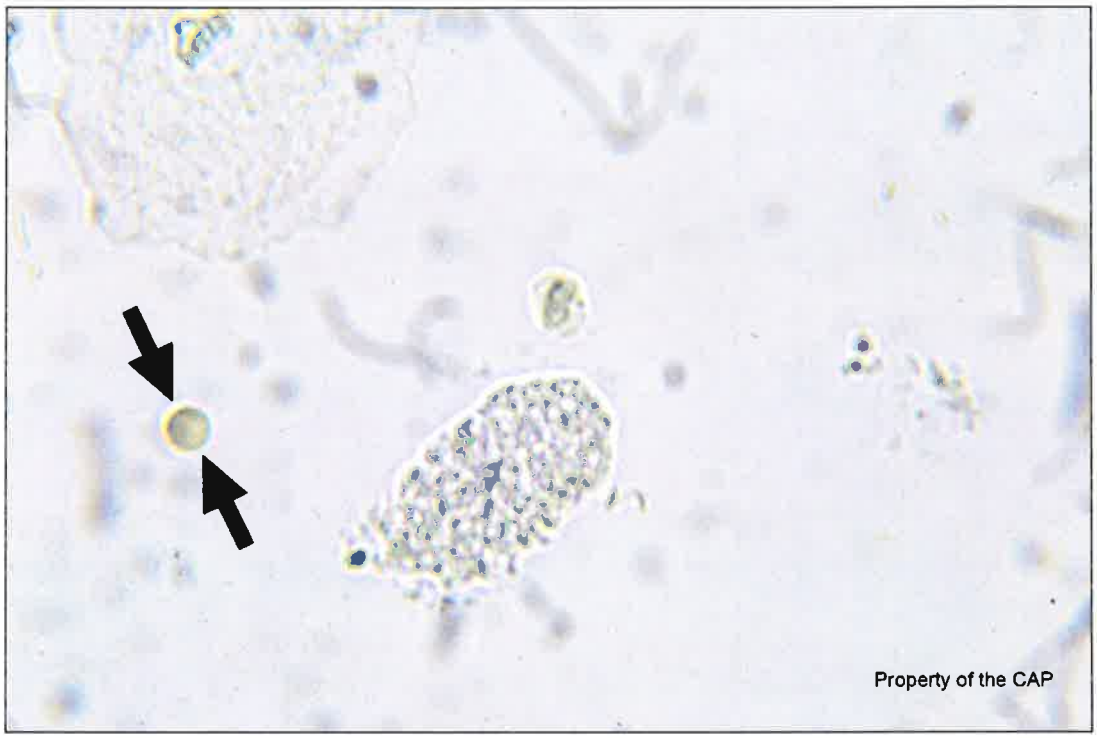
This nasal smear has eosinophils present, which exhibit the typical bilobed nucleus and numerous cytoplasmic eosinophilic granules. Nasal smears for eosinophils are an aid to distinguishing allergic rhinitis, where eosinophils are present, from non-allergic rhinitis. The clinical differential diagnosis of non-allergic rhinitis and allergic rhinitis is difficult due to the significant overlap of clinical symptomatology. In addition to the nasal smear, skin prick tests, serum IgE levels, and RAST tests may be used in conjunction with the clinical presentation to differentiate allergic and non-allergic rhinitis.

Urine Sediment Color Photographs

Case History USP-04 through USP-06

This urine sample is obtained from a 19-year-old man winterizing his car and accidentally ingested antifreeze (ethylene glycol). He was seen in the emergency room for nausea, vomiting, and possible inebriation, although no alcohol was noted on his breath. Laboratory data include: specific gravity = 1.022; pH = 5.2; blood, leukocyte esterase, and protein = positive; glucose, ketones, and nitrite = negative. Identify the arrowed image(s).
(URINE, UNSTAINED, HIGH POWER)

USP-04



Identification	Participants		Evaluation
	No.	%	
Erythrocyte	3994	98.0	Good
Fat droplet	49	1.2	Unacceptable

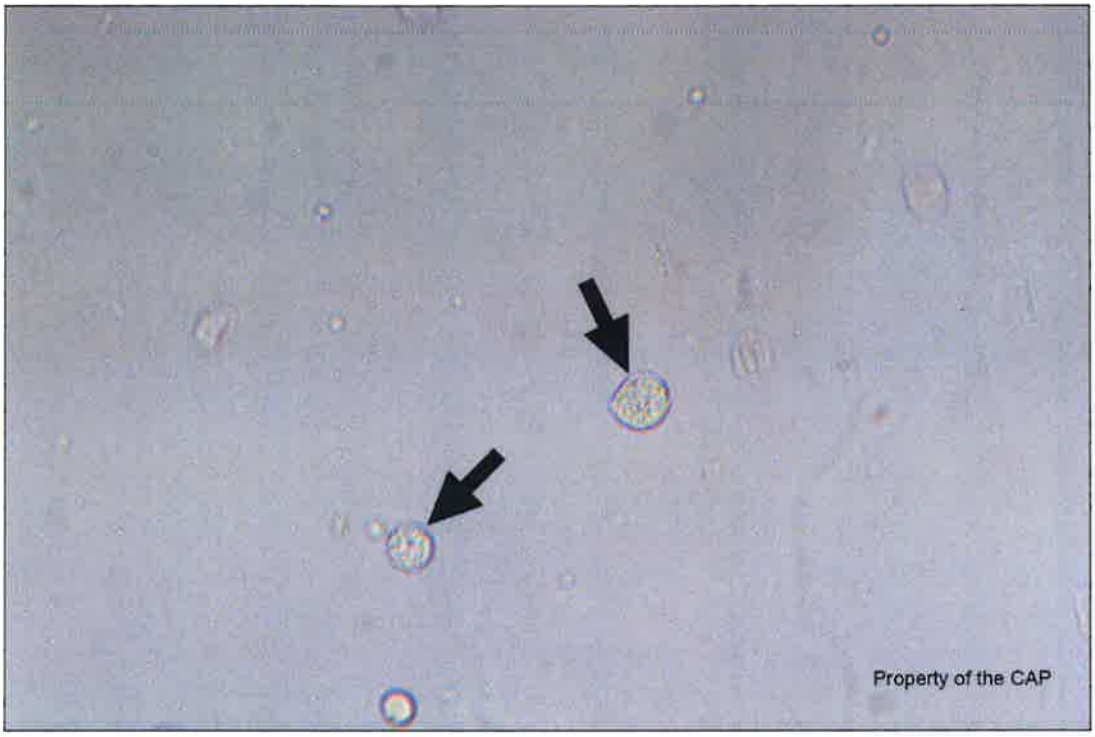
The arrowed cell is an erythrocyte, as correctly identified by 98.0% of participants. The red blood cell in this unstained wet preparation is identified by its size, color, and absence of a nucleus. This erythrocyte does not display a prominent area of central pallor that results from its biconcave shape but there is a hint of a central pallor. This red cell appears to be somewhat dehydrated consistent with the high specific gravity of 1.022 of hypertonic urine. The pink-red or pale yellow-orange color is a distinctive feature of the hemoglobin that fills its interior. Red cell size is approximately 7 to 8 µm in diameter.

Erythrocytes can usually be distinguished from leukocytes by their size and lack of granularity. Potential mimics include yeast. Yeast forms would occasionally be oval, are smaller than erythrocytes, and often show budding. Small numbers of erythrocytes can be observed in urine sediment of healthy patients. Larger numbers are indicative of injury anywhere along the upper or lower urinary tract or can be seen in states of increased bleeding such as anticoagulant therapy or bleeding disorders. False positives for erythrocytes or blood are often seen due to contamination by menstrual blood.

The arrowed object was incorrectly identified by 1.2% of participants as a fat droplet. Fat droplets can be identified by their round shape and variable size and unlike erythrocytes, are refractile. The droplets may be dark under low power, but usually are clear at high power. The refractile droplets show a Maltese-cross pattern under polarized light, and will stain positively with fat stains such as Sudan black. Fat droplets are often seen with fatty casts, and like the casts are associated with the nephrotic syndrome. Fat droplets can also be seen with contamination from oils or topical creams.

Urine Sediment Photographs

USP-05

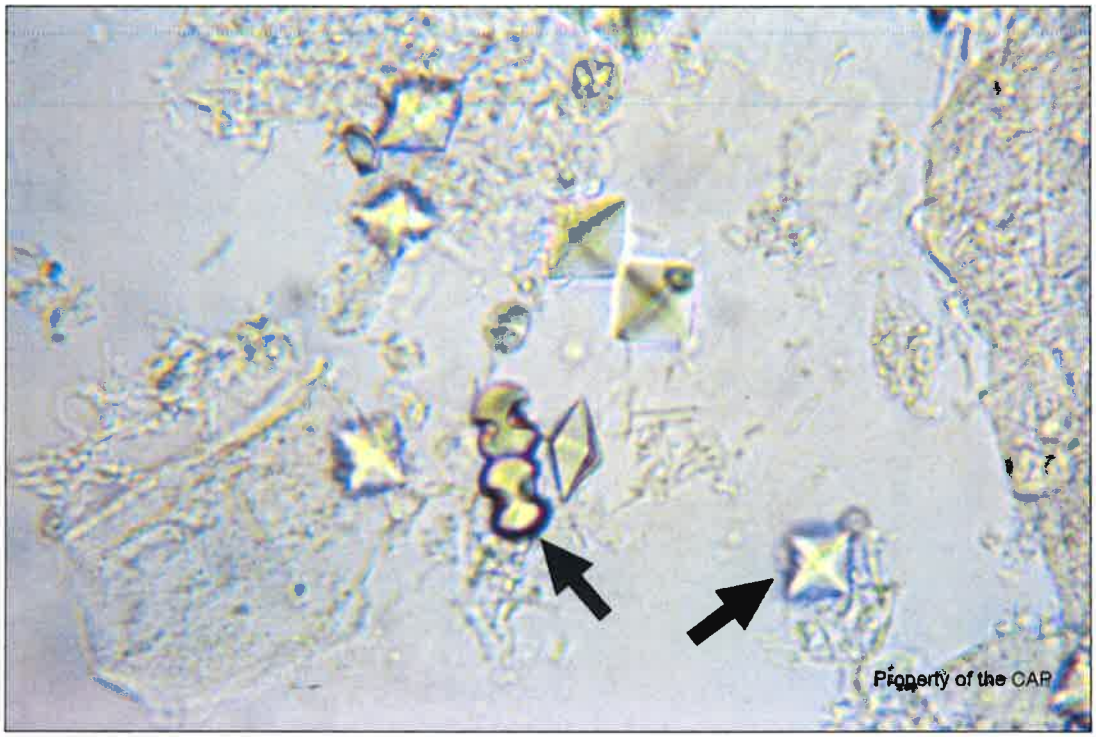


Identification	Participants		Evaluation
	No.	%	
Leukocyte (neutrophil, eosinophil, lymphocyte)	4035	99.0	Good

The arrowed cells are leukocytes, as correctly identified by 99.0% of participants. The white blood cells in this unstained wet preparation are identified as nucleated round cells approximately 10 to 12 µm, or nearly twice the size of the red cell at the bottom of the image. The most common leukocyte found in urine is the neutrophil; other leukocytes which may be present are eosinophils and lymphocytes. Neutrophils in urine are 10 - 12 µm in diameter. In this image, nuclear detail is preserved suggesting freshly voided urine. Increased numbers of leukocytes in the urine, principally neutrophils, are seen in most urinary tract disorders, particularly acute infections. Small numbers of neutrophils (up to 5 per high power field (HPF)) may be found in the urine of normal patients. The presence of larger numbers of neutrophils indicates inflammation. Many laboratories reflex a urine culture for moderate to many leukocytes, such as more than ten per HPF.

Urine Sediment Photographs

USP-06



Identification	Participants		Evaluation
	No.	%	
Calcium oxalate	4048	99.4	Good

The arrowed objects are calcium oxalate crystals, as correctly identified by 99.4% of participants. Calcium oxalate crystals occur most often in acid urine, usually as the dihydrate form. The calcium oxalate crystal on the right side of this bright field image of an unstained wet preparation is the common dihydrate form identified by its classic eight-sided colorless octahedron shape resembling stars or envelopes. The calcium oxalate crystal on the left side of this image is a rare monohydrate form identified by its dumbbell shape. In addition to being dumbbell-shaped, monohydrate crystals may also be oval- or elliptical-shaped. Calcium oxalate is strongly birefringent under polarized light which can be helpful to distinguish it from red blood cells when in an ovoid shape. Many large ovoid monohydrate forms, such as the one indicated by the left arrow in this image, are associated with ethylene glycol (antifreeze) poisoning. This finding in the urine can be a critical clue to identifying ethylene glycol poisoning in a patient.

Urine Wildcard Cell Identification Discussion

Introduction

The Hematology and Clinical Microscopy Committee is assessing the overall skill of laboratory personnel to identify nucleated cells in urine, and whether skill levels can be increased with a targeted educational effort. To this end, the B mailing of the 2021 CM survey included eight "Wildcard Challenge" images in an attempt to determine baseline proficiency of participating laboratories. This participant summary includes extra educational material on how to distinguish different nucleated cell types in urine. It includes a brief description of the different cell types, as well as the correct identification of the cells used in the challenge. We hope that laboratories will share this information with their personnel to increase overall knowledge about how to identify these cells. The College of American Pathologists *Hematology and Clinical Microscopy Glossary* and the *Color Atlas of the Urinary Sediment* are also helpful resources. A second Wildcard Challenge will be sent in the 2022 CM-A mailing, to see if this educational effort was able to improve overall performance.

Nucleated cells in urine

Nucleated cells present in urine include leukocytes and epithelial cells from the urinary tract including renal tubular epithelial cells, transitional epithelial cells, and squamous epithelial cells. Renal tubular epithelial cells line the proximal and distal convoluted tubules and collecting ducts of the nephron. Transitional epithelial cells are more distal, from the renal pelvis to the bladder and proximal urethra in men. Squamous epithelial cells line the urethra in women, and the distal male urethra; some women may also have squamous metaplasia of the trigone.

Because of their location, small numbers of transitional and squamous cells can be seen in normal urine. RTEs are usually abnormal but small numbers may not be clinically significant. Renal tubular epithelial cells (RTEs) are seen in conditions including upper urinary tract infections and tubular necrosis. Leukocytes are typically seen in reactive conditions, especially infections. The presence of both leukocytes and RTEs is characteristic of upper urinary tract infection and also tubular necrosis due to poisons/toxins. However, RTEs in the absence of significant WBCs is highly suggestive of acute tubular necrosis, which is a life-threatening condition.

These different cell types can be distinguished by cell size, cell shape, nuclear shape and location, and cytoplasmic borders and granularity. In significantly degenerated specimens, some features may be obscured.

Leukocytes

Although any type of leukocyte can be present in the urine, some, such as lymphocytes, are quite difficult to identify on unstained samples. Neutrophils however can typically be identified based on their morphology. Neutrophils are 10 - 12 µm in diameter, or up to 2x the size of a red blood cell (RBC). The cells are round to oval but may be amoeboid if the cell is activated or phagocytosing. The nucleus is segmented, and the cytoplasm is granular. Over time or with degeneration, the nuclear lobes may fuse, and the cell may lose its cytoplasmic granules.

Renal tubular epithelial cells

RTEs are larger than leukocytes, 15 - 35 µm or 2 - 5x the size of an RBC. The cell shape can vary from round to oval to polyhedral and elongated. Elongated RTE cells have typically round nuclei that may be

eccentrically located toward the basilar regions of these cells. Proximal and distal tubule RTEs can be round, oval or polygonal. Those from the proximal tubule may also have a flat edge where the apical microvillus boarder is located. Collecting duct RTEs are usually columnar but can be cuboidal or polygonal. The cytoplasm is granular. Degenerative changes include fraying of the cytoplasm, leaving indistinct cell borders.

RTEs can develop distinctive morphologies in certain conditions. In nephrosis or lipiduria, they resorb lipids and become oval fat bodies. These resorbed lipid droplets will exhibit a "Maltese cross" pattern under polarized light. RTEs infected by viruses may have nuclear or cytoplasmic inclusions, best appreciated on stained preparations. RTE cytoplasm can be stained with pigments such as bile and hemosiderin.

Transitional epithelial cells

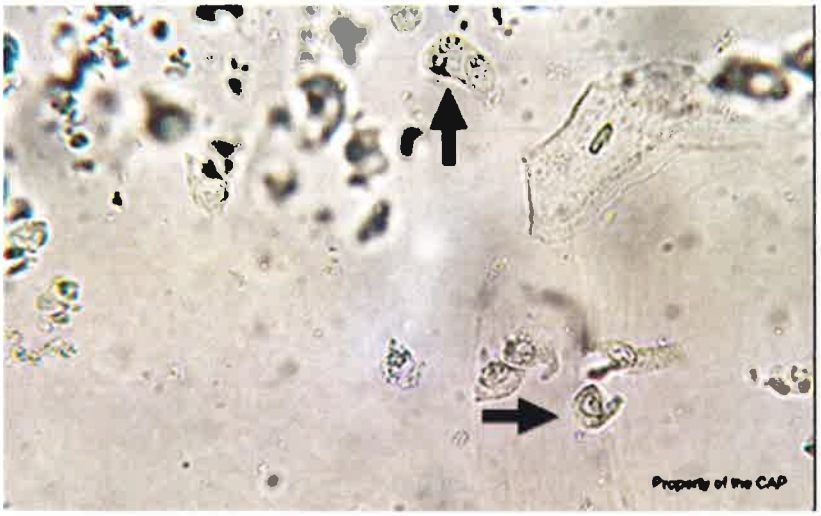
Transitional epithelial cells (TEs) may be larger on average than RTEs, 20 - 40 µm, or 4 - 6x the size of an RBC. They are usually spherical with finely granular or agranular cytoplasm, however they may occasionally have elongated "tails." Their nuclei are round to oval, more often centrally located, and approximately the size of a WBC. TEs may have a slightly lower nuclear:cytoplasmic ratio than RTEs. Despite some RTEs mimicking TEs with elongated tails, a few other features in combination distinguish one from the other. RTEs exhibit fine, somewhat indistinct cell borders with angular or flat sides, whereas TEs have well-defined, almost crisp, cell borders and appear swollen/rounded even when they have a "tadpole" shape (ie, "caudate cell"). Polar cells with eccentrically-placed nuclei and flattened or straight edges along the cell membrane opposite the elongated tail are more likely to represent RTEs than TEs. A visible apical/luminal brush border is a feature seen only in RTEs and not TEs. TEs are often shed during inflammation or due to sloughing during procedures such as catheterization or cystoscopy. TEs may appear as a monolayered cluster or sheet of cells.

Squamous epithelial cells

Squamous epithelial cells are the largest cells in the urine, 30 - 50 µm. They are polygonal and may have curled or folded cell borders. The nucleus is approximately the size of an RBC, leading to a low nuclear:cytoplasmic ratio, and may be centrally or eccentrically placed. The cytoplasm contains keratohyaline granules of varying sizes. With degeneration squamous cells may have frayed cell borders, pyknotic nuclei, and increased cytoplasmic granules.

Wildcard challenge cell identifications

WC-01

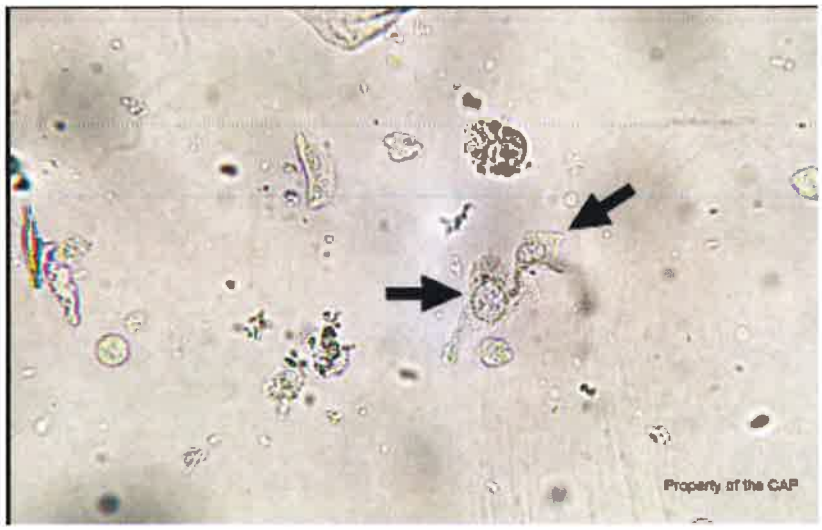


The arrowed cells are renal tubular epithelial cells. The most distinctive features in these images are the elongated shape of the cells, eccentrically placed nuclei, and cytoplasmic granularity. Three additional RTEs can be found above the lower arrowed cell. While there is no RBC in this image to serve as a size gauge, these RTEs are significantly smaller than the squamous epithelial cell in the upper right quadrant of the image. The RTE in the lower half of the picture may be smaller than typically seen.

WC-02

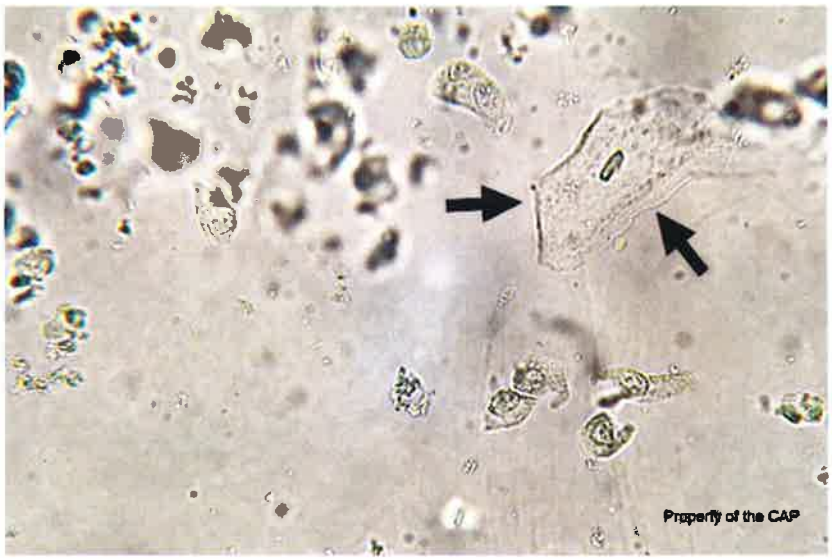
The arrowed cell is a renal tubular epithelial cell. Distinctive features in this image include the cell's size, 3 - 4x the size of the biconcave anucleate red blood cells in the image, eccentric nucleus, and elongated cell shape. There is also fine cytoplasmic granularity.

WC-03



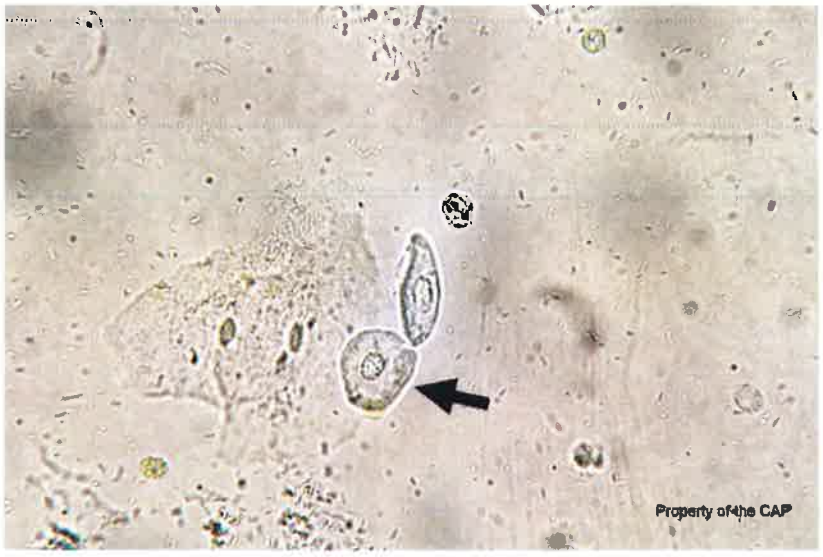
The arrowed cells in this image are renal tubular epithelial cells. They have an elongated cell shape, flattened cell membrane opposite the elongated "tail," and granular cytoplasm. The nuclei are oval to round and slightly eccentric.

WC-04



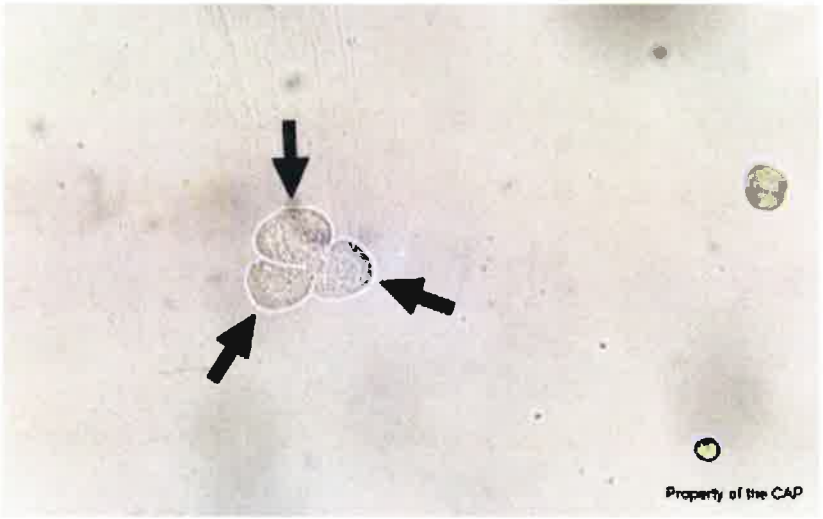
The arrowed cell is a squamous epithelial cell, recognizable by its large size, polygonal shape, and small nucleus with a low nuclear:cytoplasmic ratio. There are scant keratohyaline granules within the cytoplasm.

WC-05



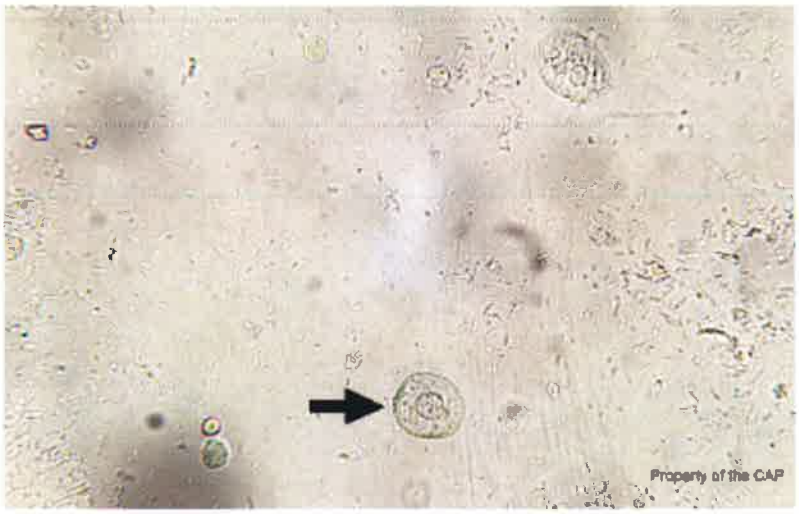
The arrowed cell in this image is a transitional epithelial cell. It is smaller than the degenerating squamous epithelial cells to the left, but significantly larger than the neutrophil in the upper right quadrant of the image. The cell is round with a distinct cytoplasmic border. The nucleus is also round and centrally placed, and the cytoplasm has fine granularity, less conspicuous than as with an RTE.

WC-06



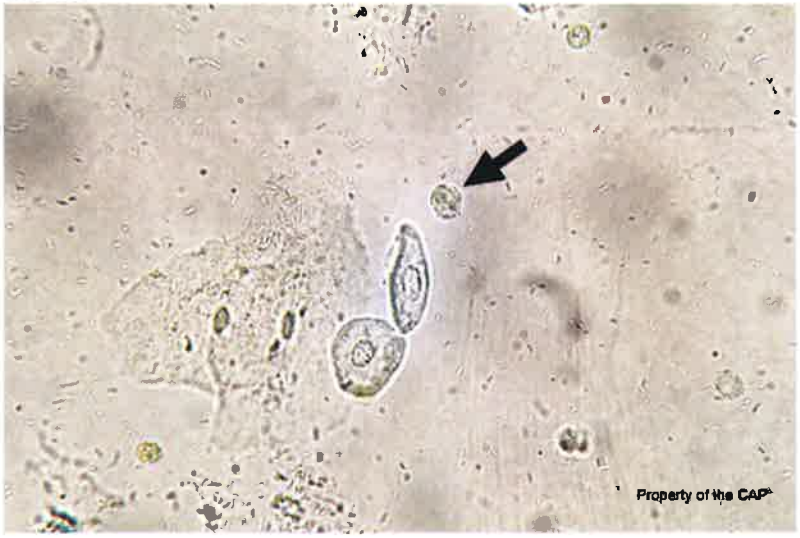
The arrowed cluster of cells are transitional epithelial cells. TEs may exfoliate in small clusters as seen here. These cells are 4 - 6x the size of the RBC in the lower right corner of the image. The cells are round with distinctive cell borders, and centrally placed round nuclei.

WC-07



The arrowed cell is a transitional epithelial cell. It is approximately 6x the size of the RBC in the lower left quadrant of the image. The cell is round with a round central nucleus. The cytoplasm shows scant fine granules.

WC-08



The arrowed cell is a neutrophil. It is smaller than the other nucleated (squamous and transitional epithelial) cells in the image, and slightly larger than the nucleus of the squamous cells. The cell is round with a distinctively lobulated nucleus.

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References:

1. College of American Pathologists. *Hematology and Clinical Microscopy Glossary.* 2021.
2. Haber MH, Blomberg, D, Galagan KA, Glassy EF, Ward PCJ, eds. *Color Atlas of the Urinary Sediment.* College of American Pathologists. 2010.