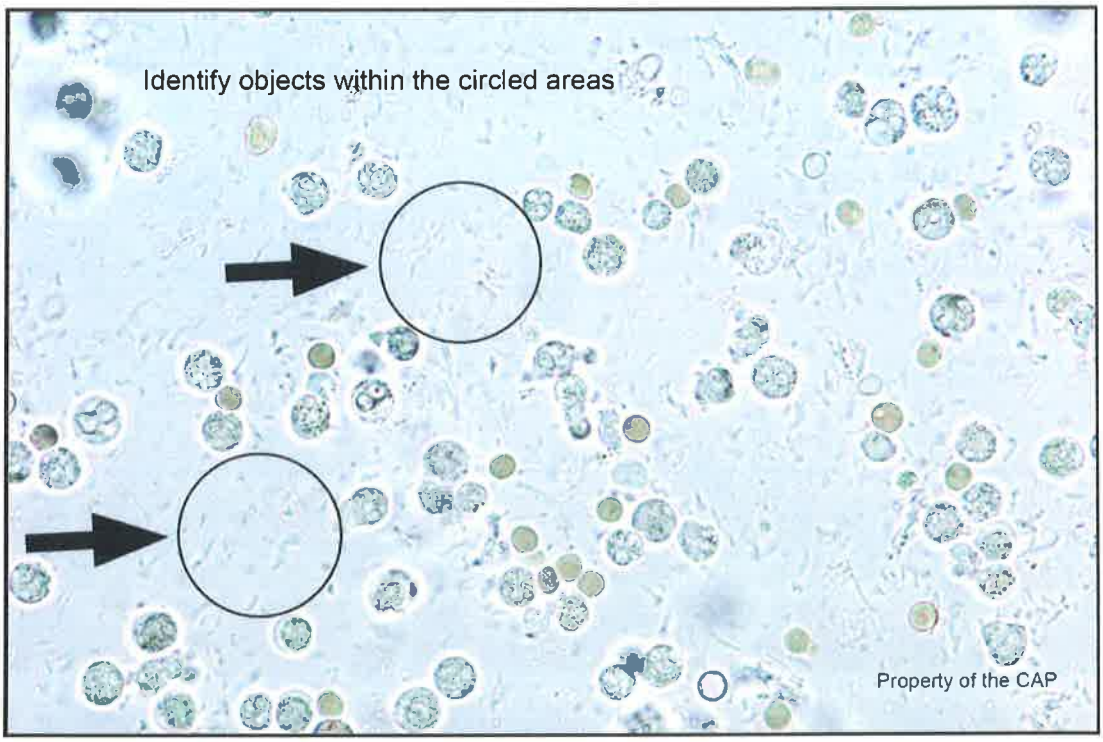
## Urine Sediment Photographs

CMP-14




(URINE, UNSTAINED, HIGH POWER)

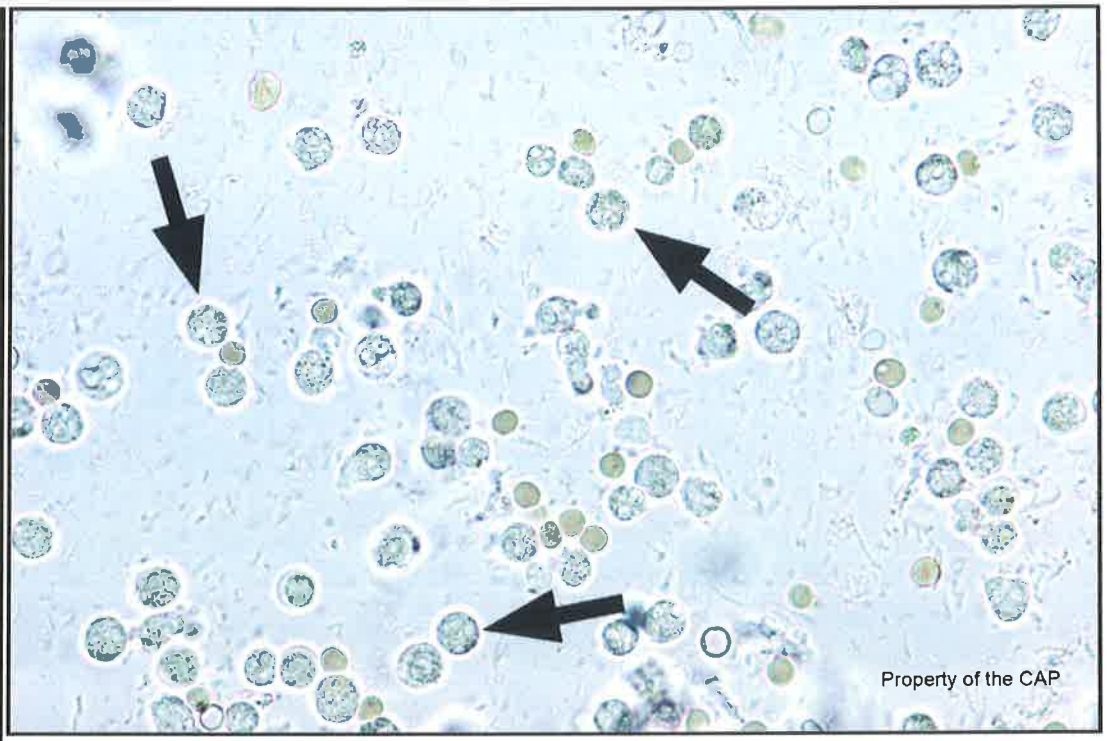
| Identification | CMP Participants No. | % | Performance Evaluation |
|---|---|---|---|
| Bacteria | 5983 | 96.6 | Good |

The arrowed objects are bacteria, as identified by 96.6% of participants. The urinary tract is normally sterile, but bacterial contamination of urine from the vagina or rectum is common due to imperfect collection technique. The bacteria in a contaminated specimen are usually a mixture of rods and cocci and are not accompanied by increased leukocytes. The presence of bacteria with a single morphology accompanied by increased leukocytes indicates urinary tract infection. In patients receiving antibiotics for a urinary tract infection, elongated bacilli with focally swollen walls, called protoplasts, may be seen. These represent bacilli with mural damage due to the antibiotics.

Bacteria, especially larger numbers of cocci, may resemble amorphous urates or phosphates. Particles of amorphous urates and phosphates show variable size and morphology, whereas most bacteria can be identified as rods and/or cocci. Gram stains of urine sediment are useful when differentiation is difficult.

## Urine Sediment Photographs

CMP-15




(URINE, UNSTAINED, HIGH POWER)

| Identification | CMP Participants No. | % | Performance Evaluation |
|---|---|---|---|
| Leukocyte (neutrophil, eosinophil, lymphocyte) | 6024 | 97.2 | Good |

The arrowed objects are neutrophils, as correctly identified by 97.2% of participants. Leukocytes in urine are most often neutrophils. Leukocytes, or PMNs, are colorless cells averaging 10 - 12 µm in diameter, with finely granular cytoplasm and rarely preserved nuclear detail. Some nuclear structure is usually visible. Leukocytes swell or shrink depending on the concentration of the urine. Leukocytes may be confused with renal tubular epithelial cells. However, renal tubular epithelial cells have a large single central nucleus and lack cytoplasmic granules.

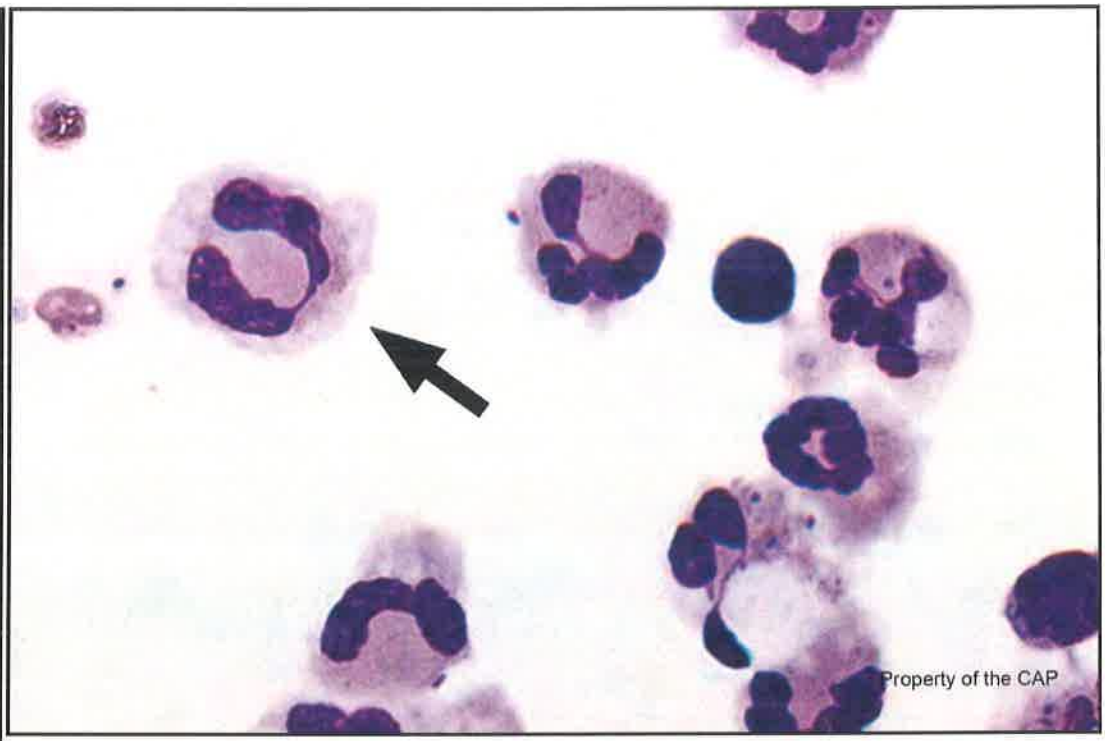
Leukocytes may be present in normal urine in small numbers, up to 5 per high power field. Leukocytes are increased in infection, urinary tract stone disease, glomerulonephritis and interstitial nephritis.

## Body Fluid Photographs

**Case History CMP-16 through CMP-18**

This patient is a 48-year-old woman being seen in the emergency room for severe headaches, stiff neck, confusion, and irritability. Cerebrospinal fluid specimen laboratory findings include: WBC = 10,000/µL (10.000 × 10E3/µL) and RBC = 65/µL (0.065 × 10E3/µL).

CMP-16




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

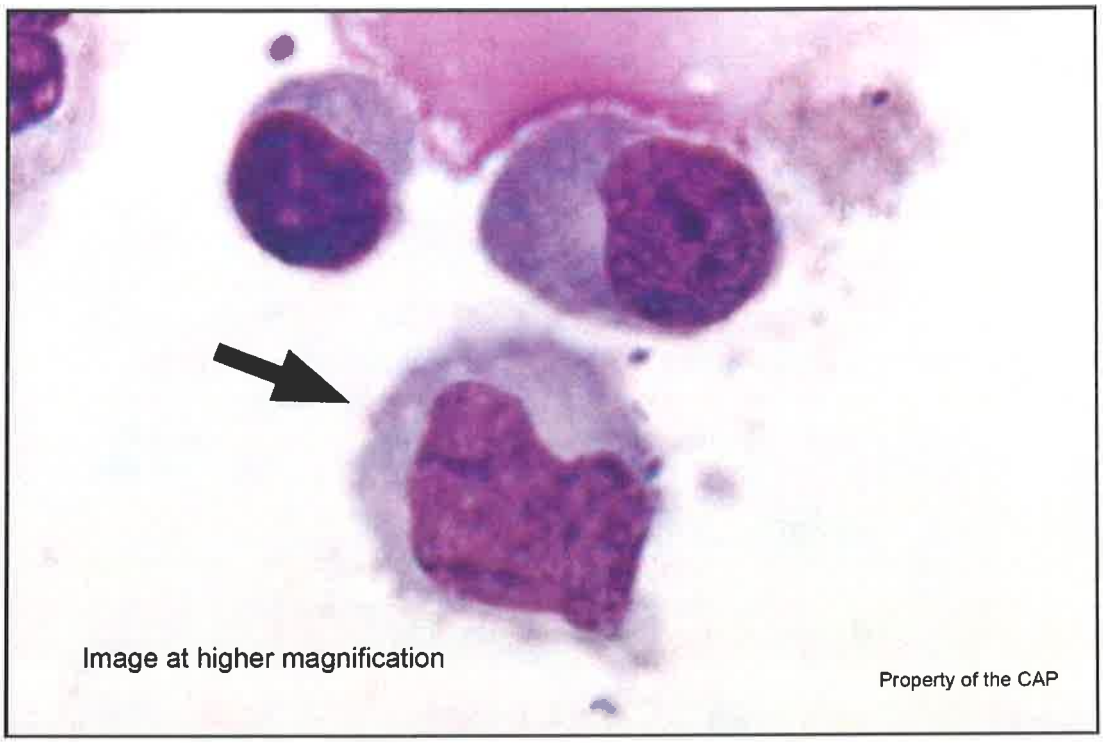
| Identification | CMP Participants No. | % | Performance Evaluation |
|---|---|---|---|
| Neutrophil, segmented or band | 3869 | 98.8 | Good |

The arrowed cell is a neutrophil, as correctly identified by 98.8% of participants. Neutrophils are usually easily recognized. In the context of inflammation, the cytoplasm may contain toxic granules or be vacuolated. Intracellular bacteria, crystals, or debris may be seen in pathologic conditions. If inclusions are present, the more specific identifications such as "neutrophil/macrophage with phagocytized bacteria" or "neutrophil/macrophage containing crystal" should be used.

Neutrophils in various fluid specimens (especially in samples from the stomach, intestine, or stool) can show morphologic change due to autolysis, including nuclear pyknosis and fragmentation, making recognition of cell type difficult. Autolytic neutrophils can be mistakenly identified as nucleated red blood cells; however, persistence of a few specific granules in the cytoplasm provides a clue to neutrophilic origin. For the purpose of proficiency testing, the identification "degenerative cell, NOS" should be chosen if the cell of origin can no longer be recognized.

## Body Fluid Photographs

CMP-17




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

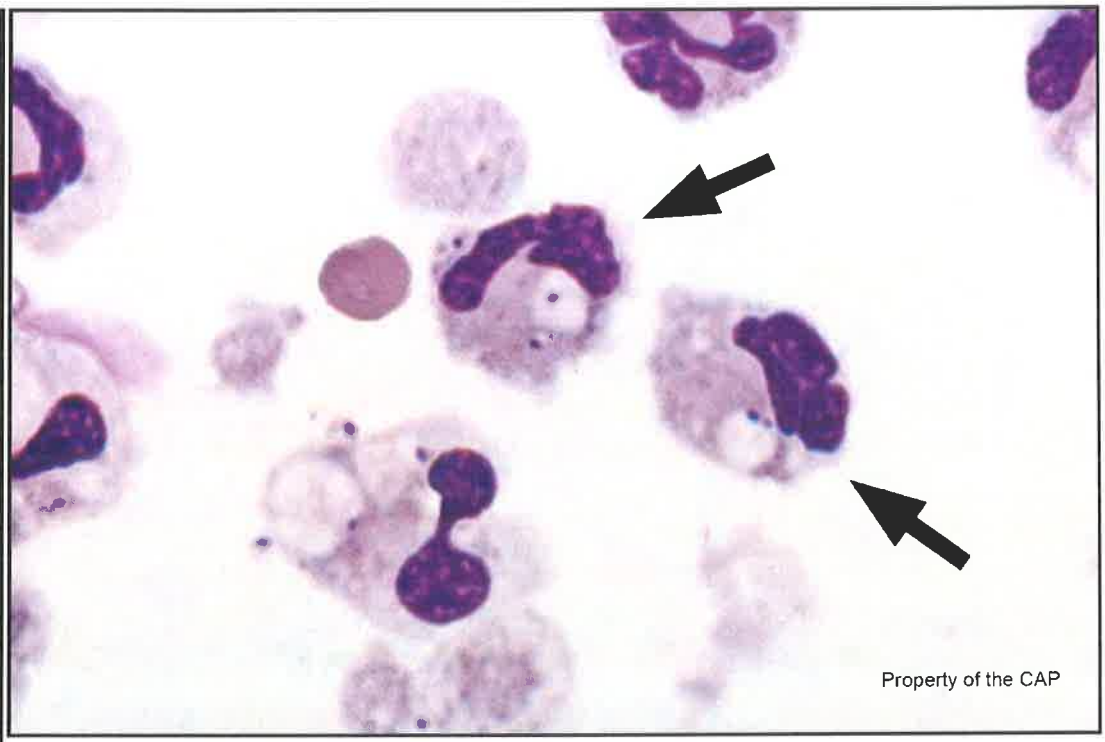
| Identification | CMP Participants No. | % | Performance Evaluation |
|---|---|---|---|
| Monocyte/macrophage | 3535 | 90.3 | Good |

The arrowed cell is a monocyte/macrophage, as correctly identified by 90.3% of participants. Monocytes are bone marrow derived cells that circulate in the blood; in contrast, macrophages arise from bone marrow derived cells that migrate into tissues. Monocyte/macrophage morphology in fluids may be variable, ranging along a continuum from the typical blood monocyte of the peripheral blood to a vacuolated, activated stage with the morphology of a typical macrophage.

Further, a variety of cytoplasmic bodies/features may be seen in macrophages. When macrophages are seen to contain uniform, small lipid vacuoles that completely fill the cytoplasm, such a macrophage would be more appropriately termed a "Macrophage containing abundant uniform small lipid vacuoles/droplets (Lipophage)." When a macrophage is seen to contain ingested red blood cells, such a macrophage would be more appropriately termed a "Macrophage containing erythrocyte(s) (Erythrophage);" similar logic applies to macrophages containing neutrophil(s) (Neutrophage), macrophage containing hemosiderin (a Siderophage), or a neutrophil/macrophage containing crystals.

## Body Fluid Photographs

CMP-18




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

| Identification | CMP Participants No. | % | Performance Evaluation |
|---|---|---|---|
| Neutrophil/macrophage containing bacteria | 3179 | 81.2 | Good |
| Neutrophils, segmented or band | 482 | 12.3 | Unacceptable |

The arrowed cells are neutrophils/macrophages containing phagocytized bacteria, as correctly identified by 81.2% of participants. Bacteria within a neutrophil or macrophage typically have a uniform appearance, usually round or rod-shaped, single, diploid, or in small chains, depending upon the species. It is important to distinguish bacteria from the normal cytoplasmic granules, debris present within a neutrophil or macrophage, pigment or hemosiderin.

12.3% of participants incorrectly identified the arrowed images as neutrophils, segmented or band. Please refer to image CMP-16 and its discussion to note the differences between a neutrophil containing bacteria and a neutrophil, segmented or band.

**Case Presentation:**

This cerebrospinal fluid (CSF) originates from a 48-year-old woman being seen in the emergency room for severe headaches, stiff neck, confusion and irritability. CSF findings include: WBC = 10,000/µL (10.000 × 10E3/µL); and RBC = 65/µL (0.065 × 10E3/µL).

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

Case Discussion: *Streptococcus pneumonia* meningitis

Meningitis refers to inflammation of the meninges, which may be caused by a number of conditions, both infectious and otherwise.[1] The vast majority of patients with underlying meningitis present with a combination of two or more conditions: headache, fever, neck stiffness, and/or altered level of consciousness.[2] As these may be relatively non-specific clinical features, the vast majority of cases will require sampling of the cerebrospinal fluid (CSF) for diagnosis; CSF sampling can provide essential materials for cytological, microbiological, and molecular studies.[1] The urgency of CSF sampling and laboratory assessment relates mainly to the need to exclude bacterial meningitis; left untreated, bacterial meningitis typically demonstrates rapid clinical deterioration.[1]

In most Western countries, acute bacterial meningitis is relatively rare in modern times; in comparison to the higher incidence of acute bacterial meningitis in developing countries, the reduction in Western incidence might be attributable to immunization practices.[2] From a global perspective, the most frequently reported cause of adult acute bacterial meningitis is *Streptococcus pneumoniae*.[2] *S. pneumoniae* is the cause of a number of bacterial infections, and may exist as a commensal or colonizing organism in both children and adults.[3]

The importance of cytological evaluation in the work-up of a putative case of meningitis, including white cell counts, cannot be overstated. Indeed, recently proposed clinical decision algorithms underscore the importance of the combination of peripheral and CSF leukocytosis, high CSF total protein, CSF lactate, and CSF glucose as highly predictive of acute bacterial meningitis.[4] Not surprisingly, higher white cell counts are associated with a higher likelihood of acute bacterial meningitis.[4] Most acute bacterial meningitides will demonstrate a profound predominance of neutrophils; in contrast, in viral entities, the predominant cell type is often lymphoid.[2]

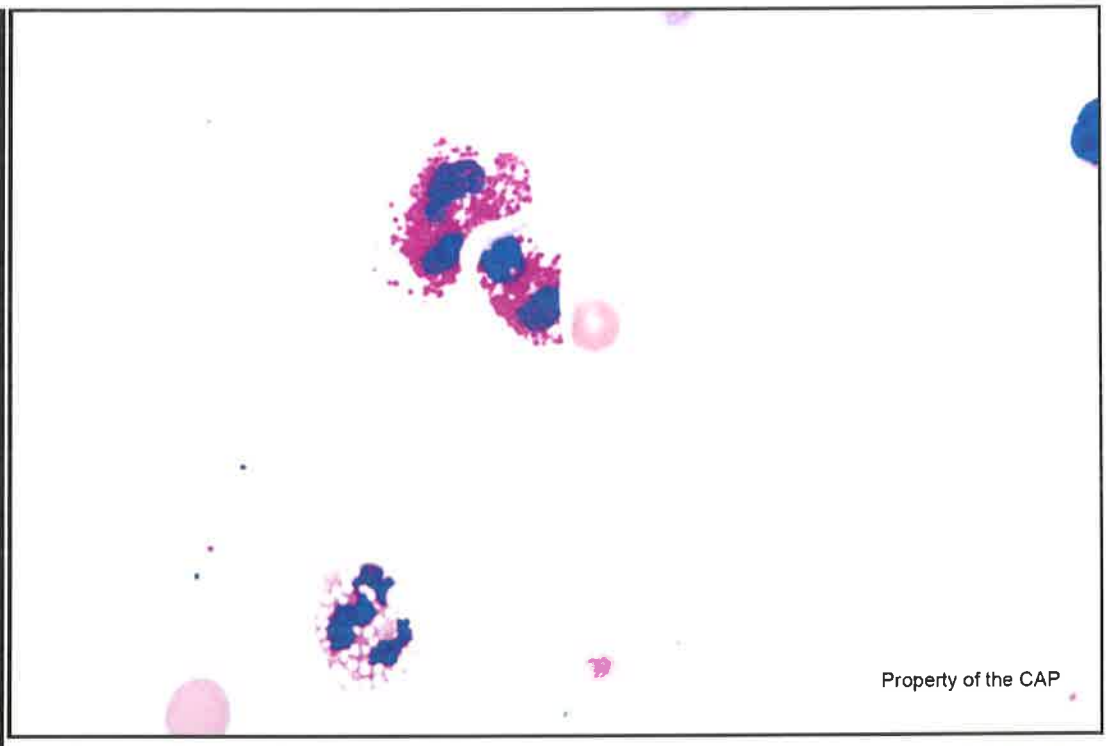
Etienne Mahé, MD, MSc, FRCPC, FCAP
Hematology and Clinical Microscopy Resource Committee

References:

1. Logan SA, MacMahon E. Viral meningitis. *BMJ*. 2008;336(7634):36–40.
2. McGill F, Heyderman RS, Panagiotou S, Tunkel AR, Solomon T. Acute bacterial meningitis in adults. *Lancet*. 2016;388(10063):3036–3047.
3. Weiser JN, Ferreira DM, Paton JC. *Streptococcus pneumoniae*: transmission, colonization and invasion. *Nat Rev Microbiol*. 2018;16(6):355–367.
4. Lagi F, Bartalesi F, Pecile P, et al. Proposal for a New Score-Based Approach To Improve Efficiency of Diagnostic Laboratory Workflow for Acute Bacterial Meningitis in Adults. *J Clin Microbiol*. 2016;54(7):1851–1854.

## CMMP – Clinical Microscopy Miscellaneous Photographs

CMMP-32




(NASAL, WRIGHT-GIEMSA) High power magnification

| Identification | CMMP Participants No. | % | Performance Evaluation |
|---|---|---|---|
| Eosinophils are present | 2163 | 99.9 | Good |

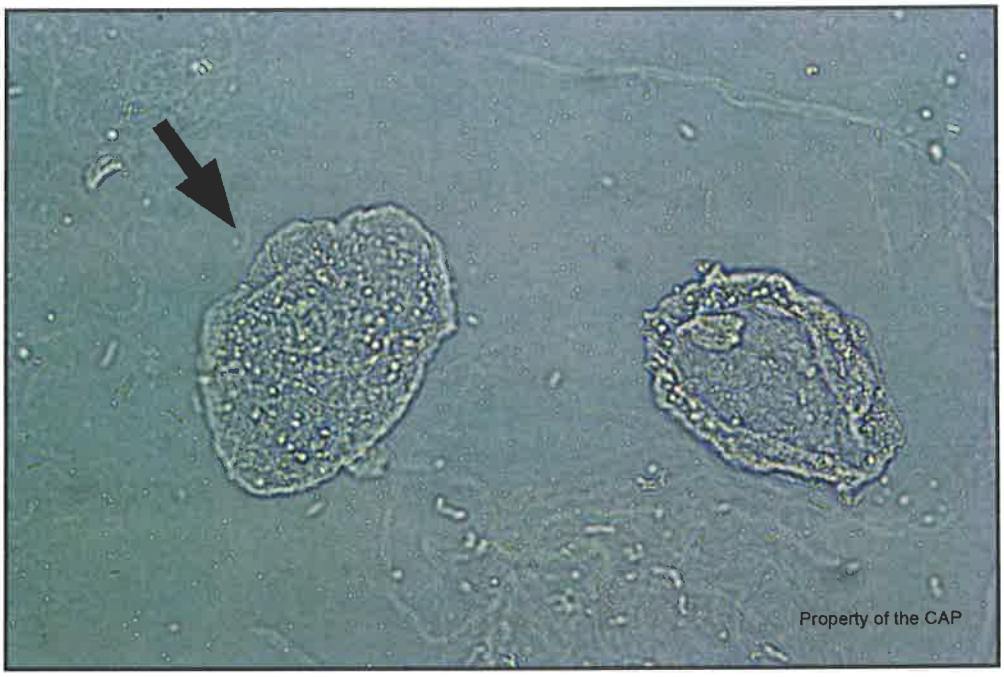
This photomicrograph demonstrates a Wright-Giemsa stained nasal smear. Two eosinophils with bright orange-red spherical granules are seen near the middle top of the image. The finding of nasal eosinophils is supportive of the diagnosis of allergic rhinitis. These cells have nuclei with two lobes separated by a thin filament. Non-allergic causes of nasal discharge will typically be acellular or show a predominance of neutrophils rather than eosinophils.

## CMMP – Urine Sediment Color Photographs

**Case History USP-04 and USP-06**

This urine specimen is from a 30-year-old woman as part of a routine exam. Laboratory data include: specific gravity = 1.020; pH = 6.5; protein and blood = positive; glucose, ketones, leukocyte esterase, and nitrite = negative.

USP-04




(URINE, UNSTAINED, HIGH POWER) High power magnification

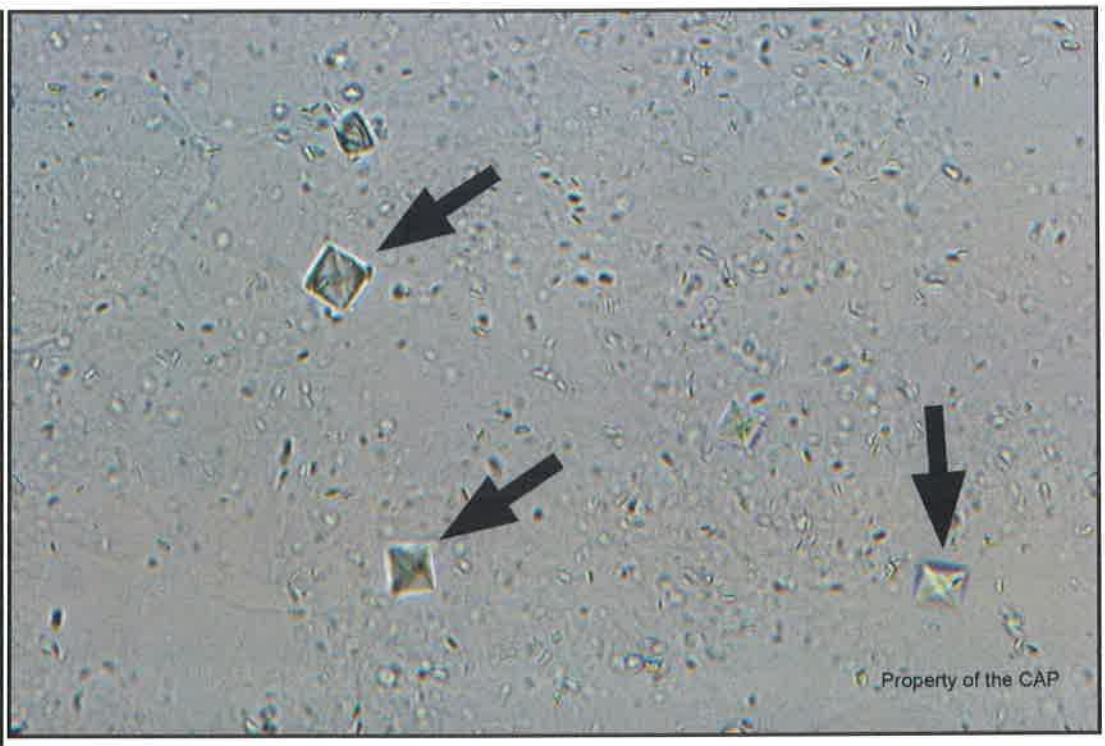
| Identification | CMMP Participants No. | % | CMMP Referees No. | % | Performance Evaluation |
|---|---|---|---|---|---|
| Squamous epithelial cell | 3107 | 73.0 | 34 | 69.4 | Non-consensus |
| Squamous epithelial cell containing bacteria (clue cell) | 1105 | 26.0 | 15 | 30.6 | Non-consensus |

The arrowed object is a squamous epithelial cell, as correctly identified by 73.0% of participants and 69.4% of referees. Squamous cells are the most common epithelial cells in the urine. Like transitional epithelial cells, they have a low nuclear-to-cytoplasmic ratio. The nucleus is small and round nucleus with dense chromatin and abundant cytoplasm. Small keratohyaline granules may be found in the cytoplasm. As is seen in most epithelial cells in the urine, the indicated cell does not have a perfectly regular cytoplasmic membrane. There are also a few refractile keratohyaline particles present.

26.0% of participants and 30.6% of referees incorrectly identified the indicated cell as a clue cell. Clue cells are squamous epithelial cells covered with numerous bacteria present in bacterial vaginosis, which are best appreciated on vaginal wet prep, although they may be present in urine as a contaminant. The squamous epithelial cells in this image can be distinguished from clue cells in that the latter have numerous small attached bacteria, which are so plentiful as the make the entire cytoplasm appear finely granular and obscure the cytoplasmic border, making it "shaggy" in appearance (refer to CMMP-36).

## CMMP – Urine Sediment Color Photographs

USP-05



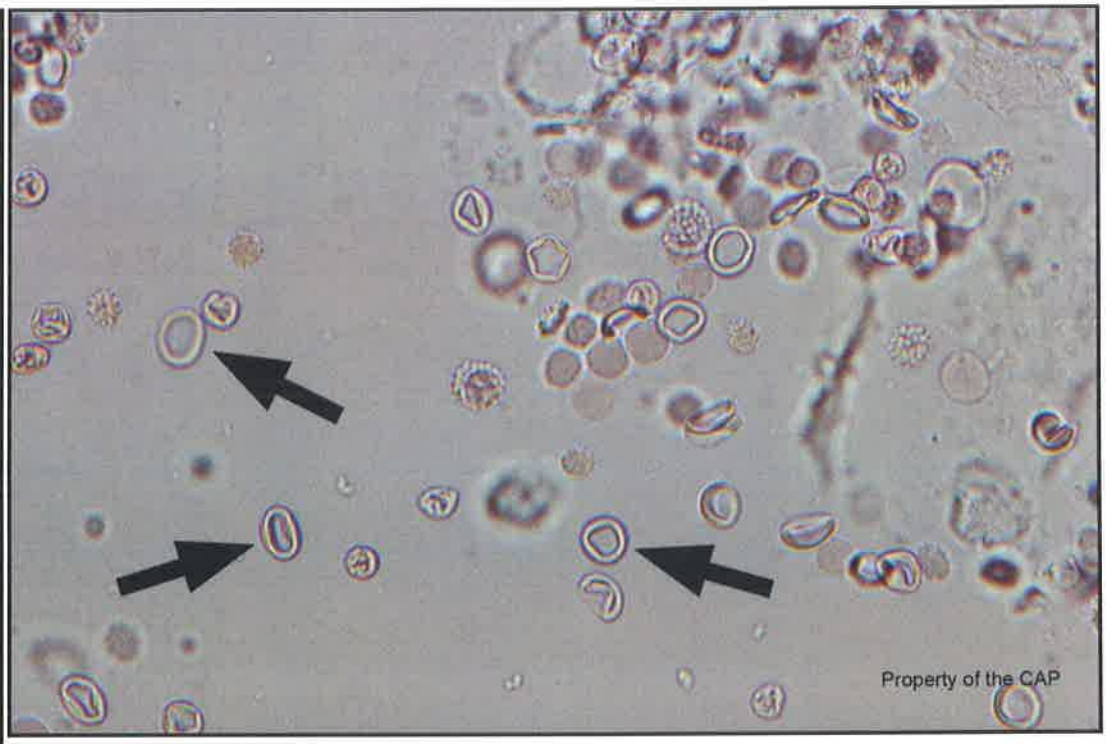

(URINE, UNSTAINED, HIGH POWER)

| Identification | CMMP Participants No. | % | Performance Evaluation |
|---|---|---|---|
| Calcium oxalate crystals | 4230 | 99.4 | Good |

The arrowed objects are calcium oxalate crystals, as correctly identified by 99.4% of participants. Calcium oxalate crystals are found in neutral or acid pH and vary in size. They may be smaller than red blood cells. Dihydrate calcium oxalate forms small colorless octahedrons that resemble stars, envelopes, or two pyramids joined at the base. All forms of calcium oxalate crystals are birefringent. Oval, elliptical, or dumbbell monohydrate forms are less commonly seen than the dihydrate form. Oxalate crystals are not usually abnormal findings, especially in patients who consume foods rich in oxalic acid, such as tomatoes, apples, asparagus, oranges, or carbonated beverages. However, in some circumstances they may suggest the cause of renal calculi.

## CMMP – Urine Sediment Color Photographs

USP-06




(URINE, UNSTAINED, HIGH POWER)

| Identification | CMMP Participants No. | % | Performance Evaluation |
|---|---|---|---|
| Erythrocytes | 3780 | 88.8 | Good |

The arrowed objects are erythrocytes, as correctly identified by 88.8% of participants. Erythrocytes, or red blood cells, are round with no nucleus. They are 7 to 8 µm in diameter and appear as pale yellow-orange discs in unstained specimens, however if the sample is old or hypotonic they may be colorless and fainter. In hypertonic urine red blood cells may become crenated.

Small numbers of erythrocytes may be found in the urine sediment of otherwise normal patients. Larger numbers may indicate disease anywhere in the kidney or urinary tract. Hematuria can also be seen in patients with bleeding disorders or iatrogenic anticoagulation or trauma. Contamination of the urine by menstrual blood frequently causes falsely positive test results.