

**IV. Microscopic Examination of Urine**

A. Definition of urine sediment: all solid materials suspended in the urine

B. Significance of formed elements in the urine

C. Specimen requirements

1. Collection of specimen

a. Prefer first morning, mid-stream, clean catch specimen.

b. Container must be clean and free of lint / debris

c. Fresh – tested within 2 hours or refrigeration needed.

2. Preparation of standardized (NCCLS) specimen

a. Mix specimen well

b. Pour 12 ml into urine centrifuge tube

c. Centrifuge five minutes, 1200-2000 RPM (speed varies depending on the centrifuge's characteristics)

d. Pour off supernatant

e. Resuspend sediment

f. Evaluate sediment in a chamber standardized for given volume and depth of field.

g. Use standardized reporting format consistent with other techs in the institution

3. Commercial systems

a. UriSystem

b. KOVA System

c. Count -6 or Count 10

4. Sedi-Stain (Sternheimer and Malbin) crystal violet, safranin-O
  - a. Brightfield microscope – very subdued light: lowered condenser, closed iris diaphragm, use filters
  - b. Polarized light - may use to ID crystals, lipids

D. Types of Sediment

1. Organized – biological part
  - a. RBC
  - b. WBC
  - c. Casts
  - d. Epithelial cells
  - e. Bacteria, parasites, yeast and fungi
2. Unorganized
  - a. Crystals
  - b. Amorphous matter

E. Examination

1. Scanning – 10-15 fields using low power (10X). Look for casts, mucous, and squamous epithelial cells
2. Enumeration
  - a. Average number of RBC/hpf
  - b. Average number of WBC/hpf
  - c. Average number of any renal tubular or transitional epithelial cells /hpf.
  - d. Average number of casts per \_\_\_\_\_
  - e. Unorganized sediment – few, moderate, many, packed; kinds seen
  - f. Note presence of bacteria, yeasts, crystals, epithelial cells, etc.

F. Changes in urine sediment when allowed to stand

1. RBC distorted – crenation, swelling, disintegration
  2. WBC disintegrates in alkaline urine
  3. Cast disintegrate in alkaline urine
  4. Bacterial growth – increased alkalinity
  5. Increased precipitation of crystals, especially amorphous
- G. Microscopic sediment
1. Red blood cells
    - a. Pathological finding - cannot appear in filtrate if nephron is intact.
      - 1) Hemoglobinuria – free hemoglobin in urine
      - 2) Hematuria – presence of intact RBCs in urine
      - 3) Result of bleeding along urinary tract
        - a) Bleeding in nephron – red cell casts
        - b) Bleeding in lower GU tract – no protein or casts
    - b. Detection
      - 1) High power
      - 2) Reduced light
    - c. Description
      - 1) yellow - red sheen
      - 2) Intact disc or may be crenated
      - 3) Highly refractile, smooth surface, round
      - 4) In dilute or alkaline urine appear as ghost or shadow cells
    - d. Confused with
      - 1) Yeast

- 2) Bubbles or oil droplets
  - 3) Ovoid shaped calcium oxalate crystals
  - e. Confirmation – test for hemoglobin
- ▶ If urine needs to be diluted prior to microscopic, must use saline. Water will lyse RBCs.

### 2. White blood cells

#### a. Significance and source

- 1) Few are normal - < 8 / hpf
- 2) Larger amounts indicate inflammation/infection
- 3) Conditions with and without presence of bacteria

#### 4) Condition called **pyuria / leukocyturia**

#### 5) May or may not cause positive reaction on dipstick

#### 6) May be found in clumps

#### b. Detection

- 1) High power
- 2) Fine adjustment

#### c. Description

- 1) Greyish-blue sheen
- 2) usually about 10-12 micron diameter
- 3) Fine cytoplasmic granulation, rough surface, may have irregular edges.

#### d. Types

- 1) Neutrophils - most common,
  - a) associated with many renal diseases.
  - b) Seen in both bacterial and non-bacterial conditions
  - c) Glitter cells - Brownian movement of granules
- 2) Eosinophils
  - a) associated with nephritis due to allergic reactions

- b) Hansel's secretion stain
  - 3) Lymphocytes
  - 4) Monocytes and macrophages/histocytes
3. Epithelial cells – cells sloughed off urethra, bladder and genital tract. Is usually a vaginal contaminant.
- a. Renal tubular epithelial – line tubules, presence in increased number can mean destruction of nephron tubules
    - 1) proximal - 20-60  $\mu\text{m}$ , oblong, cigar shaped, sometimes multinucleated
    - 2) distal - 14 - 25  $\mu\text{m}$ , round to oval shaped, small dense & sometimes eccentric nucleus
  - b. Collecting duct epithelial - 12 - 20  $\mu\text{m}$ , cuboidal, polygonal or columnar with large slightly eccentric nucleus.
  - c. Transitional epithelial cells - 40 - 200  $\mu\text{m}$ , originate from lining of renal pelvis, bladder, and upper urethra. Shape varies depending on origin. Presence is considered normal sloughing of old cells, however, increased numbers or unusual morphology may indicate abnormality.
  - d. Squamous – very large, flat, often curl or roll up. Irregular shaped. Usually can see a small round nucleus.
4. Casts
- a. Definition: Cylinder-like structures with parallel sides, formed from gelled protein. **Tamm-Horsfall** is a glycoprotein excreted by the renal tubular cells. This protein is not detected by the dipstick.
  - b. Site of formation – produced in the lumen of the distal convoluted tubule and collecting ducts.
  - c. Requirements for formation
    - 1) Sufficient protein concentration

- 2) Low pH (acid) to favor precipitation
- 3) Sufficient, increased concentration of solutes
- 4) Decreased rate of urine flow

d. Detection

- 1) Low power and low light to find; high power to identify
- 2) Cylindrical body with parallel sides and rounded ends
- 3) May be confused with cylindroids, mucous threads, and rolled up squamous epithelial cells

e. Types

- 1) Hyaline – colorless, transparent
  - a) Precipitation of protein
  - b) Normal less than 2/LPF
  - c) Reasons for increased numbers
    - (1) renal disorders
    - (2) congestive heart failure
    - (3) strenuous exercise
    - (4) heat, emotional distress, etc.
  - d) Not stable in alkaline urine
- 2) Waxy – may appear yellow, cracked, and more refractile. Has a rigid, thick appearance. Very serious, indicates end stage renal disease.
- 3) Inclusions
  - a) Fine granular – may resemble hyaline but also has small granules

- b) Coarse granular – larger granules, larger quantity.
- c) Fatty – contain fat droplets; seen with oval fat bodies as the result of fat degeneration
- 4) Pigmented
  - a) Hemoglobin / myoglobin
  - b) Bilirubin
  - c) Medication such as Pyridium
- 5) Cellular - indicates serious renal disease

<i>contents</i>	<i>indication</i>
RBC	
WBC	
epithelial cell	

- a) May form by conglutination
- b) Renal epithelial type very serious – indicates desquamation of tubules and possible irreversible damage
- c) Believe epithelial type undergo disintegration to coarse granular, then fine granular
- 6) Broad – may be any type; formed in collecting tubule because of stasis
- 7) Narrow – result from swelling of tubular epithelium with narrowing of tubular lumen
- 8) Pseudocast -

5. Crystals

- a. Acid urine
  - 1) Normal
    - a) Amorphous urates - looks like sand. Least significant of the crystals.
    - b) Uric acid – Diamond shaped, rhomboid, rosettes

- c) Calcium oxalate – envelope; may be dumbbell (also oxalic acid from ascorbic acid)
  - d) Hippuric acid
  - e) Monosodium urate - light yellow needles/rods with blunt ends
  - f) Others
- b. Abnormal – **CAUTION:** abnormal crystals should not be reported haphazardly. They are *rarely* encountered and should have the confirmation of a pathologist and confirmatory chemical tests
- 1) Cystine – hexagonal plates, colorless, refractile
  - 2) Tyrosine – black sheaves of fine needles
  - 3) Leucine – yellow, oily spheres; usually occur with tyrosine
- ▶ A neutral pH can contain both acid and alkaline types of crystals.
- c. Miscellaneous abnormal
- 1) Bilirubin -
  - 2) Cholesterol – large, flat, hexagonal plates with one edge notched
  - 3) Substances such as X-ray dye
  - 4) Medications – wide variety of shapes; vary with drug
    - a) Sulfonamide - sheaves of wheat
    - b) Ampicillin - long thin colorless needles in acid urine.
- d. Alkaline urine
- 1) Amorphous phosphates – white precipitate, looks like sand
  - 2) Triple phosphates – coffin lids
  - 3) Ammonium biurate – yellow thorn apple, burr
  - 4) Calcium phosphate – small, flat plates; wedged shaped
  - 5) Calcium carbonates – dumbbells, tiny colorless granules in pairs

6. Miscellaneous structures

- a. Mucous - threadlike, transparent. Low light is needed in order to be able to see mucous threads. Usually a vaginal contaminant. Do not confuse with casts.
- b. Bacteria – May be a contaminate from poor collection or transport. We quantitate but do not describe or try to speciate. E. coli is the most common cause of UTI.
- c. Yeast – May be a contaminant since it is normal vaginal flora. But may be seen in diabetics (since increased glucose in urine), or a patient on antibiotic treatment which suppresses other flora allowing yeast to overgrow.
- d. Parasites – usually a vaginal or fecal contaminant.
  - 1) Trichomonas - resembles a WBC but has a flagellum and moves.
  - 2) Fecal parasites - pinworm, other intestinal parasites.
  - 3) Schistosoma haematobium
- e. Sperm - whether or not to report in a UA depends on your lab. If in doubt, report. Can indicate prostatic problems in older men.
- f. Oval fat bodies - degenerating or necrotic renal epithelial cells, contain fat globules
- g. Artifacts - powder crystals, fibers, oils, hairs, misc.

H. Addis Count

- 1. Actual enumeration of casts, RBC, WBC, using a hemacytometer
- 2. Normal values vary according to author