

I. URINE ANALYSIS



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URINE ANALYSIS PROCEDURE

For a routine urine analysis, a fresh (<1 hr old), clean-catch urine sample is acceptable. If the analysis cannot be performed immediately, refrigerate the sample. (When urine stands at room temperature for a long period, casts and red blood cells undergo lysis, and the urine becomes alkalized with precipitation of salts.)

1. Pour 5–10 mL of well-mixed urine into a centrifuge tube.
2. Check for appearance (color, turbidity, odor). If a urine sample looks grossly cloudy, it is sometimes advisable to examine an unspun sample. If an unspun sample is used, make note that you have done so. In general, for routine urine analysis, a spun sample is more desirable.
3. Spin a capped sample at 3,000 rpm for 3–5 min.
4. While the sample is in the centrifuge, use the dipstick (Chemstrip, etc.) to perform the dipstick evaluation on the remaining sample. Read the results according to the color chart on the bottle. Allow the correct amount of time before reading the test (usually 1–2 min) to avoid false results. Chemstrip 10 provides 10 tests (specific gravity, pH, leukocytes, nitrite, protein, glucose, ketone, urobilinogen, bilirubin, and blood). Other strips may provide less. Agents that color the urine (eg, phenazopyridine [Pyridium]) may interfere with the reading. Dipstick specific gravity is also available on some assay strips.
5. Decant and discard the supernatant. Mix the remaining sediment by flicking it with your finger and pouring or pipetting 1 or 2 drops onto a microscope slide. Cover with a coverslip.
6. Examine 10 low-power fields (LPFs; 10× objective) for epithelial cells, casts, crystals, and mucus. Casts are usually reported as number per low-power field and tend to collect around the periphery of the coverslip.
7. Examine several high-power fields (HPFs; 40× objective) for epithelial cells, crystals, RBCs, WBCs, bacteria, and parasites (trichomonads). RBCs, WBCs, and bacteria are usually reported as number per high-power field.

Normal Urine Analysis Values

- Appearance: Yellow, clear, or straw-colored
- Specific gravity:
 - Neonate: 1.012
 - Infant: 1.002–1.006
 - Child and adult: 1.001–1.035 (with normal fluid intake 1.016–1.022)
- pH:
 - Newborn/neonate: 5–7
 - Child and adult: 4.6–8.0
- Negative for bilirubin, blood, acetone, glucose, protein, nitrite, leukocyte esterase, reducing substances
- Trace: Urobilinogen
- RBC: The exact definition of microscopic hematuria is debated, but is generally defined as >3 RBC/HPF (40×).
- WBC: 0–4/HPF
- Epithelial cells: Occasional
- Hyaline casts: Occasional

- Bacteria: None
- Crystals: Some limited crystals, based on urine pH (see below)

Differential Diagnosis for Routine Urine Analysis

- **Appearance** (see Section II: "Urine, Abnormal Color"; Section II: "Urine, Foaming; Urine, Odor; and Urine, Particles")
- **pH:**
 - Acidic: High-protein (meat) diet, ammonium chloride, mandelic acid and other medications, acidosis (due to ketoacidosis [starvation, diabetes], chronic obstructive pulmonary disease [COPD])
 - Basic: Urinary tract infections (UTIs), renal tubular acidosis, diet (high-vegetable, milk, immediately after meals), sodium bicarbonate therapy, vomiting, metabolic alkalosis, diuretic therapy
- **Specific gravity:**
 - Usually corresponds to osmolarity, except with osmotic diuresis. A value > 1.023 indicates normal renal concentrating ability:
 - Increased: Volume depletion, congestive heart failure (CHF), adrenal insufficiency, diabetes mellitus, inappropriate antidiuretic hormone (ADH), increased proteins (nephrosis); if markedly increased (1.040–1.050), suspect artifact or excretion of radiographic contrast media.
 - Decreased: Diabetes insipidus, pyelonephritis, glomerulonephritis, water load with normal renal function
- **Bilirubin:**
 - Positive: Obstructive jaundice (intrahepatic and extrahepatic), hepatitis (Note: False positive with stool contamination)
- **Blood:**
 - Positive: See Section I: "Hematuria"
 - Note: If the dipstick is positive for blood, but no RBCs are seen, free hemoglobin may be present from trauma, from a transfusion reaction, or from lysis of RBCs (RBCs will lyse if the pH is <5 or >8), or there may be myoglobin present because of a crush injury, burn, or tissue ischemia.
- **Glucose:**
 - Positive: Diabetes mellitus, pancreatitis, pancreatic carcinoma, pheochromocytoma, Cushing syndrome, shock, burns, pain, steroids, hyperthyroidism, renal tubular disease, iatrogenic causes

(Note: The glucose oxidase technique in many kits is specific for glucose and will not react with lactose, fructose, or galactose.)
- **Ketones:**
 - Detects primarily acetone and acetoacetic acid and not β -hydroxybutyric acid:
 - Positive: Starvation, high-fat/low-carbohydrate diet, diabetic ketoacidosis, vomiting, diarrhea, hyperthyroidism, pregnancy, febrile states (especially in children)
- **Nitrite:**
 - Many bacteria will convert nitrates to nitrite. (See also the section on "Leukocyte Esterase," below.)
 - Positive: Infection (A negative test does not rule out infection, because some organisms, such as *Streptococcus faecalis* and other gram-positive cocci, will not produce nitrite, and the urine must also be retained in the bladder for several hours to allow the reaction to take place.)

- **Protein:**
 - Indication by dipstick of persistent proteinuria should be quantified by 24-hr urine studies:
 - Positive: Pyelonephritis, glomerulonephritis, Kimmelstiel-Wilson syndrome (diabetes), nephrotic syndrome, myeloma, postural causes, preeclampsia, inflammation, and malignancies of the lower tract, functional causes (fever, stress, heavy exercise), malignant hypertension, congestive heart failure
- **Leukocyte esterase** (see Section I: "Pyuria"):
 - This test detects ≥ 5 WBCs/HPF or lysed WBCs. When combined with the nitrite test, it has a predictive value for UTI of 74% if both tests are positive, and >97% if both tests are negative:
 - Positive: Infection (false-positive with vaginal contamination)
- **Reducing substance:**
 - Positive: Glucose, fructose, galactose, false-positives (vitamin C, salicylates, antibiotics, etc.)
- **Urobilinogen:**
 - Positive: Cirrhosis, CHF with hepatic congestion, hepatitis, hyperthyroidism, suppression of gut flora with antibiotics (Note: With obstructive jaundice, urobilinogen is usually normal, but bilirubin is elevated.)

Urine Sediment

Many labs no longer do microscopic examinations unless specifically requested or if the dipstick test shows evidence of an abnormal finding (such as positive leukocyte esterase):

- **RBCs:** Trauma, pyelonephritis, genitourinary tuberculosis (TB), cystitis, prostatitis, stones, tumors (malignant and benign), coagulopathy, and any cause of blood on dipstick test (see above on hemoglobin)
- **WBCs:** Infection anywhere in the urinary tract, TB, renal tumors, acute glomerulonephritis, radiation, interstitial nephritis (analgesic abuse)
- **Epithelial cells:** Acute tubular necrosis (ATN), necrotizing papillitis (most epithelial cells are from an otherwise unremarkable urethra)
- **Parasites:** *Trichomonas vaginalis*, *Schistosoma haematobium* infections
- **Yeast:** *Candida albicans* infection (especially in diabetics, immunosuppressed patients, or if a vaginal yeast infection is present)
- **Spermatozoa:** Normal in males immediately after intercourse or nocturnal emission
- **Crystals:** Note that urine should be examined fresh and warm because clouding due to phosphate precipitation may be observed when urine cools:
 - Abnormal: Cystine, sulfonamide, leucine, tyrosine, cholesterol
 - Normal in acidic urine: Oxalate (small square crystals with a central cross), uric acid
 - Normal in alkaline urine: Calcium carbonate, triple phosphate (resemble coffin lids)
- **Contaminants:** Cotton threads, hair, wood fibers, amorphous substances (all usually unimportant)
- **Mucus:** Large amounts suggest urethral disease (normal from ileal conduit or other forms of urinary diversion).
- **Glitter cells:** WBCs are lysed in hypotonic solution.