MEDLAB BASICS · STUDY SHEET

Urinalysis

Collection and preservation, physical exam, reagent strip principles and interferences, confirmatory tests, sediment cells, casts and crystals, strip-microscopy correlation, renal physiology and disease patterns

27 sources + more detail
medlabbasics.com/sheets/lab-urinalysis.html
checked Nov 2026

1 Specimens and preservation

SPECIMEN	USE	NOTE
Random	Routine screening	Most contamination risk; ratios to creatinine correct for dilution
First morning	Most concentrated; protein, nitrite	Overnight bladder time can lyse cells and casts
Second morning (2–4 h after the first)	Sediment and red cell morphology	Avoids overnight lysis
Midstream clean catch	Routine and culture	Fewer squamous cells and contaminants than first-void
Catheter	Culture in catheterized patients	Aspirate from the sampling port; never from the bag for culture
Suprapubic aspirate	Culture when contamination must be avoided	Bladder puncture bypasses urethral flora
24-hour (timed)	Clearance, protein, analytes	Discard the first void, save all urine through the same time next day; refrigerate

- Test within 2 hours, or refrigerate (strip results hold about 24 hours refrigerated; sediment within 1 hour at room temperature or 4 hours refrigerated).
- Refrigeration precipitates amorphous urates and phosphates: keep an unrefrigerated aliquot when crystals matter.
- Protect from light for bilirubin, urobilinogen and porphyrins (amber container).
- Boric acid culture tubes keep pH below 7 but give false-negative leukocyte esterase, protein and ketones. No preservative suits culture, chemistry and sediment at once.
- Pour urine onto the strip, or dip only a separate aliquot: dipping a strip into a culture tube contaminates it.

EXAM TIP An unrefrigerated urine left for hours shows a typical pattern: pH up (bacteria split urea to ammonia), glucose down, nitrite and bacteria up, ketones down, bilirubin and urobilinogen down in light, cells and casts lysed, turbidity and odor up. Reject and recollect.

2 Physical examination

COLOR	COMMON CAUSES
Pale to colorless	Dilute urine: high intake, diuretics, diabetes insipidus
Dark yellow to amber	Concentrated urine; bilirubin
Orange	Bile pigments, phenazopyridine
Red or pink	Red cells (cloudy), hemoglobin or myoglobin (clear), porphyrins, beets, rifampin
Brown	Myoglobin, bile pigments, levodopa, metronidazole, nitrofurantoin
Brown-black on standing	Homogentisic acid (alkaptonuria), melanin, methemoglobin
Green or blue	Pseudomonas infection, biliverdin, methylene blue, amitriptyline, triamterene

METHOD	MEASURES	READS HIGH WITH
Refractometer	Refractive index of all dissolved solids	Glucose, protein, radiographic contrast, dextran
Reagent strip	Ionic concentration (cations release H^+ from a polyelectrolyte)	Protein over 1 g/L, ketoacids; reads low in alkaline urine
Osmometry	Number of particles (mOsm/kg)	Glucose and radiographic contrast (they add particles); the most exact measure of concentration

EXAM TIP Refractometer much higher than strip specific gravity: a non-ionic solute such as contrast or glucose. A specific gravity fixed near 1.010 in every specimen (isosthenuria) means the tubules no longer concentrate or dilute.

3 Reagent strip

PAD	PRINCIPLE	FALSE POSITIVE	FALSE NEGATIVE
pH	Double indicator	Old urine (ammonia raises pH)	Not applicable
Protein	Protein error of indicators: albumin shifts a buffered dye	Highly buffered alkaline urine (pH 9), quaternary ammonium, chlorhexidine, phenazopyridine, pad soaked too long	Globulins, light chains, dilute urine
Glucose	Glucose oxidase, peroxidase, chromogen	Peroxide or bleach contamination	Ascorbic acid, high SG, old urine
Ketones	Nitroprusside with acetoacetate (pads with glycine also react with acetone)	Acid, concentrated urine; levodopa, sulfhydryl drugs (captopril, mesna), pigmented urine	Beta-hydroxybutyrate never reacts; delay (evaporation)
Blood	Peroxidase-like activity of heme	Myoglobin, hypochlorite, bacterial peroxidase, menstrual blood	Ascorbic acid, captopril, high SG, formalin, unmixed specimen
Bilirubin	Diazo coupling in strong acid (conjugated only)	Phenazopyridine, chlorpromazine, etodolac, indican	Light exposure, ascorbic acid, nitrite
Urobilinogen	Ehrlich reaction (aminobenzaldehyde in strong acid)	Porphobilinogen, sulfonamides, PAS, colored urine	Light exposure, formaldehyde, nitrite
Nitrite	Nitrite diazotizes sulfanilamide, coupled to a pink dye	Old unrefrigerated urine, red urine	Short bladder time, non-nitrate-reducing organisms, ascorbic acid, no dietary nitrate
Leukocyte esterase	Granulocyte esterase hydrolyzes an ester; diazo coupling	Formaldehyde, vaginal contamination, colored urine	Ascorbic acid, protein over 5 g/L, glucose over 20 g/L, boric acid, some antibiotics
Specific gravity	Ion exchange releases H^+ to an indicator	Protein, ketoacids	Alkaline urine; non-ionic solutes (glucose, radiographic contrast) are not read

SAFETY Ascorbic acid reduces the peroxide or the oxidized chromogen, so blood, glucose, bilirubin, nitrite and leukocyte esterase can read negative together. Repeat at least a day after the last vitamin C dose.

4 Confirmatory tests

TEST	PRINCIPLE	USE
Sulfosalicylic acid (SSA)	Acid denatures and precipitates all proteins; graded by turbidity	Strip negative, SSA positive: non-albumin protein such as light chains
Ictotest (diazo tablet)	Diazonium salt and bilirubin in acid give blue to purple within 60 s	More sensitive bilirubin check (0.05–0.1 mg/dL); ignore pink or red

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4 Confirmatory tests CONTINUED

TEST	PRINCIPLE	USE
Clinitest (copper reduction)	Reducing substances reduce cupric ions (Benedict principle)	Strip negative, tablet positive: non-glucose sugar (galactose, lactose, fructose) or homogentisic acid
Acetest (nitroprusside tablet)	Nitroprusside and glycine	Acetoacetate and acetone in urine or serum; not beta-hydroxybutyrate

5 Sediment: cells, casts and crystals

ELEMENT	WHAT IT LOOKS LIKE	MEANING
Red cell	Smooth biconcave disc 6–8 µm, no nucleus; crenated in concentrated urine, ghost in dilute	Over 3/HPF is hematuria
Dysmorphic red cell, acanthocyte	Irregular outline and pallor, blebs or protrusions, ring (doughnut) forms	Glomerular bleeding
White cell	Round, granular, about 10 µm, lobed nucleus; glitter cells in dilute urine	Over 8/HPF: infection or inflammation
Squamous cell	Large flat polygonal cell, small central nucleus	Contamination
Transitional (urothelial)	Round or pear-shaped, central round nucleus, about 30 µm	Normal in small numbers
Renal tubular cell	About 14 µm, large eccentric nucleus, granular cytoplasm	Tubular injury
Oval fat body	Tubular cell or macrophage packed with lipid droplets	Nephrotic syndrome
Yeast	Smooth ovals of varying size, budding, pseudohyphae	Mimics red cells; diabetes
Trichomonas	Motile flagellate	Read fresh: wet-mount sensitivity falls within an hour

CAST	POINTS TO
Hyaline (0–2/LPF normal)	Normal, exercise, dehydration, fever, diuretics
Red cell	Glomerulonephritis
White cell	Pyelonephritis, interstitial nephritis
Renal tubular cell	Acute tubular necrosis, interstitial nephritis
Granular (muddy brown)	Acute tubular necrosis
Waxy, broad	Advanced chronic kidney disease, dilated tubules
Fatty	Nephrotic syndrome
Pigment (hemoglobin, myoglobin, bilirubin)	Hemolysis, rhabdomyolysis, liver failure

URINE PH	CRYSTAL	APPEARANCE
Acid	Uric acid	Yellow to red-brown diamonds, rhombs, barrels, rosettes; polarize
Acid	Amorphous urates	Yellow-brown granules, pink "brick dust" in bulk; dissolve on warming or in alkali (acid turns them into uric acid crystals)
Acid to neutral	Calcium oxalate	Dihydrate: colorless envelope (bipyramid). Monohydrate: ovals, dumbbells
Alkaline	Triple phosphate	Colorless coffin lids or fern-like X shapes
Alkaline	Amorphous phosphates	Colorless granules, white sediment; dissolve in acid, not heat
Alkaline	Ammonium biurate	Yellow-brown spheres, often spiked ("thorn apple")
Alkaline	Calcium carbonate	Small dumbbells or spheres; effervesce in acid
Acid	Cystine (abnormal)	Colorless hexagonal plates, often layered; cystinuria
Acid	Tyrosine, leucine (abnormal)	Fine needles in sheaves; yellow-brown spheres with concentric rings: liver disease
Acid	Bilirubin (abnormal)	Yellow-green clumped needles
Any	Cholesterol (abnormal)	Flat transparent plates with a notched corner; nephrotic syndrome

6 Correlating strip and microscope

FINDING	EXPLAIN IT BEFORE REPORTING
Blood positive, few or no red cells	Hemoglobin or myoglobin, or red cells lysed in dilute or alkaline urine
Red cells seen, blood negative	Ascorbic acid; or the "red cells" are yeast, oil or starch
Leukocyte esterase positive, no white cells	White cells lysed (old, dilute or alkaline urine)
White cells seen, esterase negative	Boric acid, ascorbic acid, high glucose or protein, some antibiotics; the pad reads granulocyte esterase, so lymphocytes do not react
Nitrite positive, no bacteria	Recheck: bacteria should be seen
Many casts, protein negative	A few hyaline casts with a negative pad are normal; with many casts, recheck protein with SSA (cast matrix is uromodulin, a non-albumin protein)
Glucose strip negative, Clinitest positive	Non-glucose reducing substance

⚠ **SAFETY** Call or comment on results that change management: red cell casts, a dark urine with heme positive and no red cells (possible rhabdomyolysis or intravascular hemolysis), cystine crystals, and drug crystals in a patient with rising creatinine.

7 Reference values the exam uses (ASCP)

ASCP BOC composite ranges (June 9, 2026), for exam purposes only. See the Reference Ranges page.

TEST	RANGE
Specific gravity	1.003–1.035
pH	4.5–8.0
Protein	Under 10 mg/dL (under 0.1 g/L), trace or negative
Glucose	15 mg/dL or less (0.8 mmol/L or less) or negative
Ketones	Under 5 mg/dL (under 0.5 mmol/L) or negative
Urobilinogen	Under 1.0 EU (under 17.0 µmol/L)
Bilirubin, blood, nitrite, leukocyte esterase	Negative
RBC; WBC; epithelial cells	0–3/HPF; 0–8/HPF; 0–5/HPF
Casts	0–2 hyaline/LPF

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