

Urine Reagent Strips (adapted from a former University of Iowa WEB site)

a. Blood

Reaction: The pseudoperoxidase action of erythrocytes and hemoglobin catalyzes the oxidation of various chromogens to produce the color change.

False negatives: formalin, excess nitrites, elevated specific gravity and Captopril may reduce reactivity.

False positives: oxidizing contaminants (bleach), microbial peroxidase. Very sensitive.

b. Bilirubin

Reaction: Bilirubin in the urine couples with a diazonium salt in an acid medium.

False negatives: samples exposed to light will show decreased amounts of bilirubin; excess levels of ascorbic acid.

False positives: highly colored metabolites of drugs may interfere with reading the reaction and appear as false positives.

c. Glucose

Reaction: The color is produced through a double enzymatic reaction of glucose oxidase and peroxidase. The latter enzyme reacts with a chromogen to produce the final color.

False negatives: elevations of ketones; very elevated specific gravities; excess levels of ascorbic acid.

False positives: presence of oxidizing agents (bleach).

d. Ketones

Reaction: Ketones react with nitroprusside or sodium nitroferricyanide and glycine to produce a color change.

False positives: presence of phenylketone or phthalein compounds; highly pigmented urines; some drug metabolites.

Notes: Only detects acetoacetate and acetone, not Beta hydroxybutrate that is common in diabetes and nutritional disorders.

e. Nitrites

Reaction: Nitrates in the urine are converted to nitrites by the action of gram-negative bacteria. These nitrites then react to form a diazonium salt which in turn reacts with a chromogen to produce the final color.

False negatives: excess ascorbic acid. *Animals false negatives; not reliable.*

False positives: presence of red dyes or other chromogens.

f. Ph

Reaction: A double indicator system detects the amount of hydrogen ions in the urine to produce a color change.

Interferences: If excess urine is left on the reagent strip, a phenomenon known as runover may occur. The urine from one reagent area carries reagent onto the pH test area and changes the result erroneously.

Notes: In animals, usually carnivores have more acid pH versus herbivores with more alkaline pH.

g. **Protein**

Reaction: This reaction is based on the phenomenon known as the "protein error of indicators" where an indicator that is highly buffered at a pH of 2 will change color in the presence of proteins (anions) as the indicator releases hydrogen ions to the protein.

False positives: Strongly basic urine; presence of phenazopyridine, polyvinylpyrrolidone, chlorhexidine, and bleach.

h. **Urobilinogen**

Excretion of urobilinogen is enhanced in alkaline urine; therefore, the best sample to collect for urobilinogen tests is that voided two hours after a meal.

Reaction: Urobilinogen reacts with a chromogen to form an azo dye which appears as various shades of pink or purple. This reaction occurs best at room temperature.

False negatives: Excess nitrites; presence of formalin.

False positives: Presence of phenazopyridine; very warm urine.

i. **Leukocytes**

Reaction: Leukocyte esterase, present in granulocytes, catalyzes the reaction of the chromogens to produce a color change.

False negatives: Gentamicin, elevated glucose and protein concentrations, tetracycline.

False positives: Drugs producing red urine, vaginal contamination.

Notes: Generally not reliable in animals.

j. **Specific Gravity**

Reaction: This reaction is based on change of an indicator color in the presence of high concentrations of various ions.

Notes: Use refractometer. *Test strips are not reliable in animals. Scale not high enough for many species.*

Transitional Epithelial Cells

Transitional epithelial cells are a little smaller than squamous epithelial cells (20-40 μm). They can vary in size depending on the origin of the cell, but are very regularly (smoothly) shaped. The shapes vary from round with a tail-like process to pear-shaped. They have a round, centrally-located nucleus which appears small in relation to the overall size of the cell. In cases of urinary tract infections, increased numbers of transitional epithelial cells can be seen. Sheets or clusters of cells indicate that the patient has undergone some instrumental procedure like catheterization. Transitional cells have the ability to absorb water which causes them to be very round and appear larger than a squamous epithelial cell. Neoplasia can result from these cells and appear as atypical clusters of cells with marked variation in size.

Note: Current kits to detect neoplastic transitional cells have false positives with WBCs > 30-40/hpf and RBC > 30-40/hpf. This is a significant problem.

Renal Tubular Epithelial Cells

Renal tubular epithelial cells (RTC) are round cells about the size of a white blood cell (15 μm in diameter). They contain a single large nucleus usually located eccentrically. Increased numbers of renal tubular cells indicates necrosis of the tubules. They are present in pyelonephritis, toxic reactions, viral infections, allograft rejection and the secondary effects of glomerulonephritis.

They can contain absorbed pigments like bilirubin or non-lipid filled vacuoles. In addition they can absorb lipids and are then called oval fat bodies. Lipid is common in healthy cat renal cells.

If unsure about cell morphology, make slides and stain to examine.

Clinically Significant Casts

While a few hyaline casts can be found in urine from normal individuals, extensive numbers will indicate some renal disease. The following casts are also clinically significant. Recall that casts vary in length and thickness; but the diameter is uniform throughout the length of each cast, the sides are parallel, and the ends are rounded. Think cigar-shaped when looking for casts.

As the fibrils of the cast form, the most common elements in the urine can become entrapped within the matrix. Cellular casts will have at least three identifiable cells within the matrix; and if the cells can be further identified, the cast will be called by that cell name. As the cells in the cast degenerate, they form the coarse granules in the coarsely granular cast.

Current Theory of Cast Genesis

The most current theory of cast formation takes finely granular casts out of this sequence and gives it a genesis of its own. This theory suggests that finely granular casts contain elements from deteriorating renal tubular cells. These elements become trapped into the protein matrix as it coagulates within the tubule.

White blood cell casts are formed when leukocytes enter the urine stream by amoeboid movement through and between the tubular epithelial cells or by passing from the glomerular capillary lumen across the basement membrane into the renal tubule lumen. The number of cells present in the cast may vary from a few to several. White blood cell casts are usually indicative of a renal inflammatory process such as pyelonephritis. The presence of white cell casts is usually accompanied by free and clumped white cells in the urine. If both white cell casts and red cell casts are present, the cells may be of glomerular origin as in diseases like glomerulonephritis.

Waxy casts are the result of the coalescing of the protein in the matrix of the cast and further degeneration of the cellular elements entrapped in the cast. The protein becomes brittle and can crack and break easily. These casts have a high refractive index and blunt ends and appear colorless, yellowish or gray in color. They also have an opaque surface and serrated margins which often become creviced because they are so brittle. Waxy casts are found in patients with long standing chronic renal disease or chronic renal failure. Their presence implies tubular obstruction with prolonged stasis.