The Complete Urinalysis and Urine Tests

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By Wanda Lockwood, RN, BA, MA

Purpose

This course aims to explain the components of the urinalysis in detail and the values and purposes of a wide range of urinary testing.

Course objectives

Upon completion of this course, one should be able to:

- Describe the anatomy of the kidney and nephron and production of urine.
- Explain 8 different types of urine collection.
- Explain the significance of the components of a routine urinalysis.
- List reference values for routine urinalysis.
- Explain at least 4 factors that can influence the color of urine.
- Discuss at least 4 factors that can increase or decrease specific gravity.
- Discuss factors that affect acidity/alkalinity (pH) of urine.
- Discuss the implications of glucose, ketones, nitrites, and leukocyte esterase in the urine.
- List and discuss 6 urine electrolyte tests.
- Describe 6 types of sediment that may be found in urine.
- List and describe at least 6 different associated urine tests.

Introduction

The urinary system comprises the kidneys, ureters, bladder, and urethra. The kidneys filter unwanted waste materials from the blood and regulate the levels of water and chemicals in the body. The average adult cardiac output is about 1200 mL per minute, and about 25% of that is received by the kidneys per minute. About 99% of the fluid circulating through the kidneys is reabsorbed into the blood with the remaining excreted as urine. Approximately 1000 liters of blood filtered through the kidneys produces one liter of urine.

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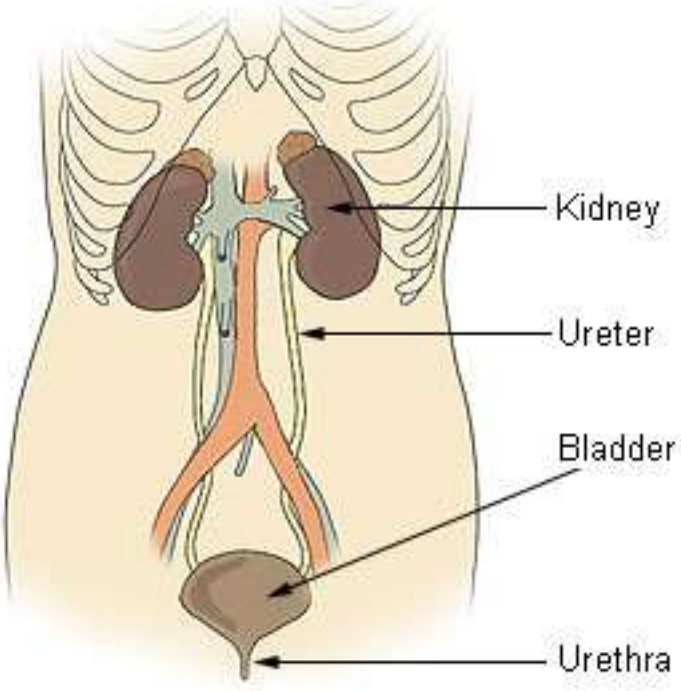
Components of the Urinary System



The nephron is the kidney's primary functional unit with each kidney containing approximately 1 million nephrons. Nephrons are specialized coiled filtering tubules (about 1 inch in length) comprised of a glomerulus, Bowman's capsule, and a tubular system:

- **Glomerulus:** Twisted ball-shaped capillary network (tuft) surrounded by Bowman's capsule.
- **Bowman's capsule:** Double membrane cup-shaped structure that surrounds the glomerulus.
- **Tubular system:** Proximal convoluted tubule, loop of Henle (central area of nephron), and distal convoluted tubule.

The cortex (outer layer) of the kidney is comprised of the glomeruli and Bowman's capsules as well as the proximal convoluted tubules and the ascending loops of Henle. The medulla (central area) of the kidney contains the descending loops of Henle and distal convoluted tubules. **[See CE course: Renal Function Tests.]** In the absence of bladder or kidney infection, urine is sterile until it reaches the urethra, which may be contaminated by bacteria.

The urine that is produced by the kidney is a by-product of some of the kidney's primary functions, which include:

- Waste excretion (urea, creatinine, drug metabolites, sulfates, uric acid).
- Maintaining electrolyte balance (such as sodium, chloride, potassium, and magnesium). For example, with normal kidney function 630 grams of sodium are filtered each day, 626.8 grams are reabsorbed, and 3.2 grams (0.5%) excreted in the urine.

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- Acid excretion (products of protein breakdown),
- Water excretion/reabsorption, depending on fluid balance.

Urine comprises primarily:

- Water (95%).
- Urea.
- Chloride.
- Sodium.
- Potassium.
- Creatinine.
- Trace amounts of other ions, inorganic compounds, and organic compounds.

The Urinalysis

Hippocrates (430-377 BC) noted that the condition of urine could reflect health. Through history, people created charts of urine color to help diagnose disease and by the 17th century, practitioners began tasting urine to help diagnose diabetes. Urinalysis has become more sophisticated since those times, but the urinalysis remains one of the first tests done for diagnosis of disease, especially diseases that may remain essentially silent until they are advanced. The urinalysis is a simple and noninvasive test that provides valuable information.

Urinalysis is often done as part of a general health evaluation, but UA can also assist in the diagnosis or monitoring of a number of disorders or conditions:

- Systemic or metabolic diseases that affect kidney function (such as malaria and sarcoidosis).
- Endocrine disorders (such as diabetes mellitus).
- Kidney or urinary tract disorders (such as pyelonephritis, glomerulonephritis, and cystitis).
- Pregnancy.
- Drug abuse.

A urinalysis requires 3 types of examination:

- Direct observation to note color, odor, and consistency.
- Dipstick analysis: Tests include pH, specific gravity, protein, glucose, ketones, nitrite, and leukocyte esterase.
- Microscopic analysis: Sediment is examined for red blood cells, white blood cells, epithelial cells, casts, bacteria, yeast, and crystals, and other material (such as sperm and pinworm ova).

Types of urine specimens

Over the course of a 24-hour period, the composition and concentration of urine changes continuously. For this reason, various types of specimens may be collected. Generally, about 10 mL of urine is

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required for routine urinalysis. Urine specimens should be refrigerated if they cannot be examined within 2 hours because urine begins to break down after that time, becoming more alkaline, and rendering some urine tests inaccurate.

Type of collection	Discussion
Random	There are no particular precautions to avoid contamination. Single random specimens may be taken at any time of the day or night although usually the first voiding in the morning is discarded because the dehydration that occurs during the night may alter values.
First morning specimen	This is taken before ingestion of fluids. This sample is usually hypertonic and is done to evaluate the ability of the kidneys to concentrate urine during the normal dehydration that occurs during sleep. Because early morning specimens tend to be more concentrated, some abnormalities may be easier to detect, and the specimen is generally free of dietary and exercises influences that may alter values.
Double-voided	This is a specimen obtained after the first emptying of the bladder and waiting until a second voiding to collect the specimen. This is particularly useful for glucose as a specimen that has been maintained in the bladder for hours (such as overnight) may not accurately reflect glucose levels at the time the specimen is taken.
Clean catch ("Midstream")	This is used for urine culture and cytological analyses. It may also be used for routine urinalysis in order to prevent contamination of the sample. It is obtained after cleansing about the urethral meatus with an antiseptic solution, such as benzalkonium hydrochloride. The first half of the urine flow is not collected in order to flush contaminants, but the collection cup captures the last half of the stream. Clean catch is especially important for females as it reduces contamination from vaginal secretions. Specimens obtained during menses should be clean catch and a tampon should be used, if possible, to prevent contamination of the specimen with menstrual fluids.
Catheterized	This may be obtained with a straight catheterization or from an indwelling Foley® catheter. If a Foley® catheter is in place, it is better to collect the sample directly from the catheter rather than the draining bag, but if protocol prevents disconnection, the drainage bag should be emptied and then a sample collected from fresh urinary drainage. Catheterization is avoided if possible because of the danger of trauma or introduction of infective agents. However, catheterization may be necessary for patients who are confused.
Suprapubic	This method is used most commonly for infants or small

transabdominal needle aspiration	children but may be used for bedridden patients who cannot be catheterized. It provides a very pure and sterile specimen.
Timed (2-72 hours) collection	Timed collections are used for a variety of tests. The rate excretion of various substances may vary throughout the day, so collecting a random sample may not give an accurate representation of the urine. It's especially important that when collecting urine for a specified time period that ALL urine be collected as even discarding one sample may skew results. ***Procedure for 24 hour collection:*** • Begin collection in the morning, but do not save the first urination; however, record the time of urination as the beginning point. • Collect all urine is container provided by physician or laboratory (usually 4 L container with small amount of preservative). • Store the container in a refrigerator the entire 24 hours. • Urinate into small clean container and pour urine into the larger container. Avoid touching the inside of either container. • Urinate at the end of the 24-hour period for the final time and save that specimen. • Record the final time. • Avoid getting any toilet paper, pubic hair, stool, menstrual blood, or other material in the urine. • Deliver to laboratory within 4 hours. In some cases, urine may be saved in two separate containers, one for daytime collection and the other for nighttime. For some conditions, longer specimen collection (up to 72 hours) may be indicated.
Pediatric collection	Special urinary collection bags that are attached to the genital area are used to collect urine specimens for infants. Before applying the collection bag, the genital area must be cleansed with mild soap and dried. The adhesive backing is removed from the collection bag and the adhesive surface carefully applied to the skin, checking for a complete seal. The specimen is transferred to a sterile container immediately after the infant urinates. If collecting a sample for dipstick testing, placing a cotton ball in the diaper and then swabbing the wet cotton provides adequate results. Additionally, wiping the external genitalia with a sterile wipe may stimulate the infant's voiding reflex.

Reference values for normal urinalysis

It is important to check with each agency's laboratory for normal reference values as they may vary slightly.

Characteristic	Expected measurement
Color	Pale yellow to amber
Appearance	Clear to slightly hazy
Odor	Slight
Volume	1500 mL/24 hours (750 – 2500 range)
Specific gravity	1.001 – 1.040 (usually 1.015 with normal fluid intake)
pH	4.5 – 8 (average is 5-6)
Glucose	Negative
Ketones	Negative
Protein	Negative
Nitrite for bacteria	Negative
Leukocyte esterase	Negative
Casts	Negative (occasional hyaline casts)
Red blood cells	Negative or rare
White blood cells	Negative or rare
Crystals	Negative
Epithelial cells	Few

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Color, appearance, odor, and volume

Color is usually pale yellow/ amber and darkens when it becomes concentrated, but excessive fluid intake and some foods medications, stress, and exercise, may affect color. Urochrome is the pigment that gives urine its characteristic yellow color. A variety of medications and other agents may cause the urine to change color. The most common cause of discoloration is blood, which may give the urine a pink, red, or smoky appearance.

Blood appears in the urine with many disorders, and small amounts of bleeding caused by medications may also appear as color change. Patients taking medications that alter urine color should be advised to prevent alarm. Additionally, the laboratory should be notified if urine testing is ordered.

Color change	Medication	Other causative agent
Dark/brown	Cascara Ferrous salts/iron dextran Methocarbamol Metronidazole Nitrofurantoin Senna (in laxatives) Chloroquine Levodopa	Liver disorders, such as acute hepatitis, cirrhosis, and liver cancer, which cause bilirubin to be excreted in the urine (foamy if urine shaken)

	Methyldopa Nitrates Quinine Sulfonamide	
Yellow-brown	Bismuth Cascara Nitrofurantoin Senna Chloroquine Metronidazole Primaquine Sulfonamides	Liver disorders that cause urine to be excreted in the urine.
Blue or blue green	Amitriptyline Triamterene Methylene blue Methocarbamol Indomethacin Cimetidine Phenergan	Artificial food coloring Asparagus Hypercalcemia
Orange/yellow	Chlorzoxazone Heparin Rifampin Warfarin Dihydroergotamine Phenazopyridine (Pyridium®) Sulfasalazine Vitamin B complex Carotene	Liver disorders Carrot juice Dehydration
Red/pink	Daunorubicin or doxorubicin Ibuprofen Phenothiazines Phenylbutazone Propofol Salicylates Heparin Methyldopa Phenytoin Rifampin Senna	Blackberries Beets Blood (may relate to disease, exercise, or medications) Artificial food coloring Rhubarb Chronic lead or mercury poisoning

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Appearance should be clear but may be slightly cloudy. Cloudy urine (white or yellow) may be evidence of infection with pus or microscopic blood present, but it can also be caused by kidney stones, foods, vaginal discharge, and dehydration.

Sometimes with urinary infections, long purulent strands may be noted in the urine specimen.

Odor should be very slight, but some foods and medications, such as estrogen, may affect odor. Some bacteria may give urine a foul odor, depending upon the organism. Urine left at room temperature for >2 hours tends to develop an ammonia odor as bacteria converts urea into ammonia. If an ammonia odor is noted in a freshly voided specimen, this probably indicates that bacteria are active in the bladder, converting urea to ammonia. Some foods (such as asparagus), medications, and metabolic disorders may produce a strong or distinctive urine odor.

Volume of urine for a healthy adult is about 750 and 2500 mL of urine in 24 hours, or approximately 25 to 30 mL per hour. Children's output varies by age and size:

- Infants and toddlers: 2-3 mL/kg/hr.
- Preschool and young school age: 1-2 mL/kg/hr.
- School age and adolescents: 0.5-1 mL/kg/hr.

Although children urinate smaller overall quantities, the volume is greater in related to body size. Urinary output may vary according to fluid intake and fluid loss. For example, people may lose body fluids through perspiration at high temperatures, decreasing urinary output and increasing thirst to compensate:

- Polyuria is increased urinary output.
- Oliguria is decreased urinary output.
- Anuria is a complete lack of urinary output.

Specific gravity

Specific gravity	1.001 – 1.040 (usually 1.015 with normal fluid intake)

Specific gravity measures the kidney's ability to concentrate or dilute urine in relation to plasma by comparing the weight of urine (particles) to the weight of distilled water (1.000). Because urine contains various substances, such as minerals and salts, the specific gravity is normally higher than that of water, usually ranging from 1.005 to 1.025, but the specific gravity may increase with an increase of other substance, such as protein, in the urine or if the fluid content falls, such as with dehydration.

Dyes, such as radiopaque contrast material, are excreted in the urine and temporarily increase the specific gravity. As urine becomes more concentrated, the specific gravity increases. Because infants' kidneys are less efficient at concentrating urine than adults, the specific gravity of infants tends to be lower.

If abnormal substances (proteins, glucose, dyes) are not present in the urine and the kidney produces concentrated urine with an increased specific gravity, the primary causes include:

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- Dehydration (Most common).
- Increased secretion of anti-diuretic hormone (ADH). ADH increases tubular water re-absorption, resulting in decreased volume of urine. Various factors, such as trauma, stress, surgery, and medications, can result in an increased ADH secretion.

A decreased specific gravity occurs when the urine becomes more dilute:

- Diabetes insipidus occurs with absent or decreased anti-diuretic hormone (ADH) because of impairment of the pituitary gland. Because ADH concentrates the urine, the kidneys produce large amount of urine (15 to 20 liter/day) with a decreased specific gravity.
- Kidney disease, such as glomerulonephritis or pyelonephritis, may interfere with the ability of the kidneys to filter and to reabsorb fluid, so the urine may have low specific gravity as well as overall decreased volume of urine
- Renal failure usually results in a fixed specific gravity between 1.007 and 1.010 as the functional nephrons hypertrophy in an effort to compensate. The kidneys compensatory reactions result in urine that is essentially isotonic with plasma, regardless of time or day or fluid intake.

pH

pH	5-9 (average is 5-6)

Urine pH measures the acidity of urine to determine if it is acidic or alkaline and serves as a screening test for renal, respiratory, and metabolic disorders along with other tests. Neutral urine is 7, so urine with a pH below this number is categorized as acidic (the norm) and urine with a higher pH is alkaline. The kidneys acidify the glomerular filtrate from about 7.4 to about 6 when it is excreted as urine.

The kidneys strive to maintain the acid-base balance through reabsorption of sodium and tubular secretion of hydrogen and ammonium ions. Retention of sodium results in increasingly acidic urine.

The pH has an important role in the development of renal calculi. Acidic urine can result in xanthine, cystine uric acid, and calcium oxalate stones while alkaline urine can result in calcium carbonate, calcium phosphate, and magnesium phosphate stones. If stones are associated with acidic urine, then the diet is modified to keep the urine alkaline, and vice versa.

Acidic urine pH **<6 – 7 pH**	High protein diet Acidosis Uncontrolled diabetes Diarrhea

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	Starvation and dehydration Metabolic or respiratory acidosis
Alkaline urine pH **>7 – 8 pH**	Urinary tract obstruction Ingestion of citrus fruits Vegetarian diet Ingestion of milk, dairy products Pyloric obstruction Salicylate intoxication Renal tubular acidosis Chronic renal failure Metabolic and respiratory acidosis.

Protein Normally, urine is free of protein or has only a trace, but proteinuria occurs with renal disease. While both albumin and globulin may be excreted in the urine, albumin filters more readily than globulin, so protein in the urine is primarily albumin. Because of that, the term albuminuria is often used. Since proteins are necessary for the formation of casts, this sediment is often seen on microscopic examination of urine when proteinuria is present.

Usually glomeruli filter out protein, but when glomeruli are damaged, permeability increases and protein is able to pass through into the urine. Although a small amount of protein can sometimes be found in urine, the amount should not exceed 10 mg per 100 mL of a single specimen for 150 mg in 24 hours. The first indication of renal disease is often the finding of small amounts of albumin in the urine (microalbuminuria).

A positive finding of protein in the urine should be followed by a 24-hour urine collection for examination. While the dipstick examination can detect protein, it cannot detect abnormal proteins, such as globulins and Bence-Jones proteins found in multiple myeloma.

Urine protein testing is done to evaluate kidney function, and assist in detection of Bence Jones proteins and diagnosis of myeloma, macroglobulinemia, lymphoma, and amyloidosis. Since proteins are necessary for the formation of casts, this sediment is often seen on microscopic examination of urine when proteinuria is present.

Proteinuria is described based on the following scale:

Description	**Mg/ 24 hours**
Trace	<150 mg
1+	200-500 mg
2+	500-1500 mg
3+	>2500 mg
4+	>3000 mg

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Women with preeclampsia may exhibit massive loss of protein in the urine, so urine check for protein is a routine part of prenatal care. If there is evidence of proteinuria, then a 24-hour urine specimen may be obtained for further analysis. The 24-hour specimen should not contain >500 mg/protein.

Some people develop postural proteinuria, which occurs after prolonged periods of standing. This may be evaluated by collecting an early morning specimen with the person lying flat and then a second two hours after the person has been up and walking around. If postural proteinuria is present, the first sample is negative and protein is found in the second.

Glucose

Glycosuria, glucose in the urine, is an indication of abnormality. Normally, <0.1% of glucose filtered by the glomeruli is passed into the urine (<130 mg/24 hrs.). The renal threshold for glucose is about 160 to 190 mg/dL /blood. Below this level, the kidneys are able to effectively reabsorb glucose, but when the blood level exceeds, this, the kidneys cannot keep up and glucose begins to spill over into the urine. Thus, increased glucose in the urine indicates hyperglycemia or a reduction in the renal threshold for glucose.

While the most common cause of glycosuria is diabetes, the renal threshold may decrease during pregnancy, causing increased glucose in the urine. Additionally, eating a meal very high in carbohydrates or receiving carbohydrate infusion with hyperalimentation faster than the pancreas can produce insulin may result in temporary glycosuria. Some people simple have a lower renal threshold and may exhibit glucose in the urine even though their blood glucose level is normal.

Ketones

Urine is usually negative for ketones. Ketones are metabolic end products of rapid fatty acid metabolism. Ketones are normally formed in the liver and are completely metabolized so the urine should be free of ketones or contain only a trace. However, if carbohydrates are unable to be used for energy, the body utilizes fat, and ketones are formed as a byproduct. Ketones may occur if there is an insufficient amount of insulin, such as can occur with diabetes, or an insufficient amount of carbohydrates, such as can occur with a high protein, low carbohydrate diet. Ketones may also occur with starvation, anorexia, and severe prolonged nausea and vomiting as the body tries to compensate by burning fat for energy.

If ketones occur because of a low-carbohydrate diet, they are of little concern, and many people on high protein, low carbohydrate diets (such as Atkins) monitor ketones to determine if they are burning fat. However, if ketones result from the inability of the body to utilize carbohydrate for energy, then this is grave cause for concern as the patient may be developing ketoacidosis, which is life threatening.

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Ketones are usually evaluated by dipstick method, using Ketostix® or similar products. The dipsticks change color to indicate whether urine is negative or positive for ketones. While there is some variation among different products, the following is approximate:

- Negative: 0 mg/dL.
- Trace: 5 mg/dL.
- Small: 15 mg/dL.
- Moderate: 40 mg/dL.
- Large: 80 mg/dL.
- Very large: 160 mg/dL.

In the past, ketones were frequently monitored with diabetic patients, but since general use of blood glucose monitoring, monitoring urine is done less frequently. However, urine should be tested for ketones if blood glucose is >250. While urine testing is adequate for screening and routine assessment, it is not as accurate as serum testing for diabetic patients, so those who are diabetic and have symptoms, such as nausea and vomiting, should have a blood test for ketones.

Patients switching from insulin to oral hypoglycemic agents usually monitor ketones because an increase in ketones in the urine in the first 24 hours after switching to oral agents usually indicates inadequate response to the oral medications.

Urinary Nitrites and Leukocyte Esterase

Most species of Gram-negative bacteria that colonize in the urine produce nitrate reductase enzyme, which causes nitrates, derived from dietary metabolites, to be converted to nitrites. Both the urinary nitrite test and the leukocyte esterase (LE) tests are usually negative. Urinary nitrites and leukocyte esterase tests combined provide a good screen for urinary tract infections,

Because not all bacteria produce nitrites, a negative nitrite test alone does not necessarily mean that the urine is free of all bacteria. Nitrites are present with Gram-negative bacteria. The best results from a urinary nitrite test occur if the urine has been in the bladder for at least 4 hours, so an early morning clean catch or midstream specimen is best. Testing is done using a dipstick with reagent:

- Test results may not be accurate if the patient is urinating frequently, undergoing diuresis, or has inadequate intake of nitrates:
- False positive may occur if the dipstick has been exposed to air for ≥1 week, the specimen is contaminated with vaginal secretions, or the patient is taking phenazopyridine.
- False negatives can occur with increased specific gravity, decreased pH (<6.0), increased urobilinogen, low nitrate diet, and vitamin C

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supplements.

Additionally, it's important to keep in mind that only bacteria that produce the nitrate-changing enzyme will cause a positive reading, so a negative finding doesn't preclude all urinary infections.

Most white blood cells contain the enzyme leukocyte esterase (LE). If only a few white blood cells are present in the urine, the dipstick test is negative, but if the white cell count increases, the leukocyte esterase test is positive, indicating an infectious process somewhere in the urinary tract, most frequently a bladder infection. It can also indicate infection with gonorrhea. However, white blood cells may be present in vaginal secretions, so care must be taken to avoid external contamination of the urine specimen. The LE test is also used to screen for gonorrhea and for amniotic fluid infections.

Urinary tract infections may be asymptomatic, so these tests provide an indirect method of assessing infection, especially in those at risk, such as those with a history of UTIs, pregnant and school-age females, and the elderly.

Microscopic Examination of Urine Sediment

A microscopic examination of urine sediment detects the presence and amounts of:

- Cells
- Microorganisms
- Spermatozoa
- Mucus
- Casts
- Crystals

Cells

Cells may be difficult to identify because most cells do not remain stable in urine but rapidly begin to degenerate, changing the visual appearance, especially if cells originate high in the urinary system (such as in the proximal tubular system). Cells that originate within the bladder tend to be more easily identifiable. White blood cells in the urine are indicative of infection. The most common white blood cell found in urine is the polynuclear neutrophil. Normal neutrophil count is 6-7 (high power field) and an increase usually indicates an inflammatory process. An increase in mononuclear leukocytes usually indicates that a systemic infection has invaded the urinary system.

After the urine sediment is examined for bacteria, casts, crystals, and epithelial cells, it is assessed under a high power field (HPF) for the presence of red and white blood cells. Red blood cells are not a normal finding in urine and should appear rarely (2-3 per high power field). Hematuria may result from mechanical trauma (kidney stones, injuries, or urinary catheterization) or ingestion of

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nephrotoxins but is often an indication of urinary disease, including glomerular disease, acute tubular necrosis, bladder infection, kidney infection, urinary tract tumors, and renal infarcts.

Two different types of red blood cells may occur in the urine. If the hematuria is associated with the lower urinary disease, red blood cells usually maintain their normal appearance. However, if the disease process occurs higher in the urinary tract, the appearance is often dysmorphic. If red blood cells in the urine are oddly shaped, this may result from glomerular disease. The red blood cells become misshapen during passage through abnormal glomerular structures. The urine specimen must not contaminated by menstrual fluids, so women should use a tampon if possible during menstruation and collect a midstream specimen.

A finding of normal epithelial cells in the urine is usually of no significance because they line the vagina and distal urethra. Transitional epithelial cells (urothelium) line the urinary tract and normally shed (exfoliate) as epithelium is renewed. An increased rate of exfoliation and increased levels of epithelial cells in the urine may indicate a disease process. An increase in squamous epithelial cells within the urine often indicates external contamination of the urine specimen. Abnormal cells may indicate a malignancy.

Oval fat bodies may be found in urine. These are renal cells that have absorbed cholesterol and triglycerides.

Microorganisms

Urine stored in the bladder is normally free of microorganisms. However, bacteria are commonly found in urine specimens because normal flora of the vagina and external genitalia are an abundant source of microorganisms and any bacteria present in the urine tends to multiply rapidly if the urine is not examined immediately and is left at room temperature. If an infection is present, there is usually an increased white blood cell count along with increased bacterial count but if urine is contaminated, the white blood cell is often low. When bacteria is found in the urine, the nitrite test may help to indicate if infection is actually present, but the definitive test is culture and sensitivity.

If there are significant bacteria, a colony count may be conducted. A urinary infection is usually characterized by >100,000 of one organizer per mL urine while finding multiple different bacteria usually results from contamination of the specimen.

Yeast may also be present in the urine and can be derived from contamination from vaginal secretions. Yeast cells may, in some cases, be difficult to differentiate from red blood cells or other cells. The most common yeast found is *Candida albicans*. Diabetic patients often have frequent urinary yeast infections because of glucose in the urine. Yeasts with casts are often indicative of

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pyelonephritis.

Parasites are rarely found in urine, with the exception of *Trichomonas*, which usually derives from genital contamination although it can arise from visceral or prostate colonization in rare cases. Some viral infections may be evident in urine specimens. The most commonly observed are herpes simplex, cytomegalovirus, and polyoma virus.

Spermatozoa
Sperm is a common finding in urine and results from sexual activity. Males may have residual drainage of sperm that contaminates the urine while females have vaginal contamination. Some labs do not routinely report sperm found in urine, but since it may be indicative of sexual abuse in children, any findings in children or in suspected rape cases should be reported.

Mucous
Mucous threads are commonly found in urine and are usually benign as mucous cells are found throughout the urinary system.

Casts
Casts are essentially urinary debris. The primary types include:

- Granular: Formed from protein and decomposition of cells. May occur with renal disease, viral infections, or lead intoxication.
- Hyaline cats: Found in renal disease, heart failure, hypertension, nephrotic syndrome as well as with fever, exposure to cold temperature, exercise, and diuretic use.
- RBC casts: Found in acute glomerulonephritis, lupus nephritis, and subacute bacterial endocarditis.
- Waxy casts: Found in chronic renal failure and conditions associated with renal stasis.
- WBC casts: Found in lupus nephritis, acute glomerulonephritis, interstitial nephritis, and acute pyelonephritis.

Casts are generally reported by number and type observed though low power field. Thus, a report may state: “4-6 waxy casts/LPG.” Additionally casts may be described by width: narrow (1-2 RBCs in width), medium (3-4), and broad (5). The width helps to identify where the casts develop. For example, when casts forming in the collecting tubules are usually broad. Broad casts are often present with significant reduction in the functional capacity of the nephron and severe renal damage or "end stage" renal disease.

Hyaline casts are the most common and some may be normal, but evidence of other types of casts indicates a need for follow-up testing. A few hyaline casts (the most common type) are normal, but all other casts need to be evaluated. Granular casts develop when cellular cast/debris remains in the nephron for an

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extended period. At first, the granular casts are course, but if they remain longer before being flushed out of the kidney by urine, they degenerate to a fine granular cast and finally to a waxy cast. Thus, different sizes and types of granular casts may be found in the urine. A large pigmented granular cast (dirty brown) may indicate ischemic tubular necrosis.

White blood cell casts usually contain neutrophils and are found in diseases that active C3 factor, such as pyelonephritis, acute interstitial nephritis, and some glomerular diseases. Red blood cell casts are of particular significance because they usually indicate glomerular bleeding from glomerulonephritis. Red blood cell casts are often found in conjunction with proteinuria and hematuria.

Hemoglobin casts may occur with hemolysis (such as from malaria) and myoglobin casts from breakdown of muscle tissue (crush syndrome), but these casts usually are filtered into the urine from the blood rather than developing in the urinary system.

Fatty casts may occur with nephrotic syndrome and are usually associated with proteinuria although they may occur in healthy individuals.

Crystals
Some forms of crystals appear in the urine of healthy individuals and most crystals, except for cystine, are not considered clinically significant. Freshly voided urine specimens are often devoid of crystals, but alkalization and refrigeration may promote crystal formation. While crystals are found in kidney stones, the presence of crystals in the urine does not necessarily relate to stone formation. Cystine crystals, however, are found only in patients with cystinuria, a genetic impairment of tubular reabsorption of basic amino acids (lysine, arginine, ornithine, and cystine).

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Other urine testing

There are many other urinary constituents that are measured to establish a diagnosis or to monitor treatment. Many of these tests require a 24-hour sample. Some require a blood sample comparison. Values given (adult) are for reference only and may vary from one lab to another, depending on the procedures and equipment used for testing.

Electrolytes: Calcium and chloride

Test	Discussion
Calcium	**(Normal values: 100-300 mg/24 hours if on average diet, but 50-150 mg/24 hours on low-calcium diet)** Both serum and urine testing may be done for calcium to assess parathyroid gland dysfunction. The parathyroid glands help maintain balance between body calcium and phosphorus via the

	secretion of parathyroid hormone. Serum testing is more accurate to identify pancreatitis or bone disorders that may be affecting calcium levels. Urine testing is usually done to determine if kidney stones relate to high urine calcium levels and to diagnose parathyroid disorders. • Decreased values may occur with hypoparathyroidism, malabsorption, pancreatitis, alkalosis, vitamin D deficiency, severe subcutaneous infection, peritonitis, large infusion of citrated blood, chronic diarrhea, decreased parathyroid hormone, and renal failure (diuretic phase). • Increased values may occur with hyperparathyroidism, malignant neoplastic disease, prolonged immobilization, overuse of calcium supplements, vitamin D toxicity, renal failure (oliguric phase), acidosis, corticosteroid therapy, thiazide diuretic use, increase parathyroid hormone, and digoxin toxicity. Testing is done with a 24-hour collection. Random voided specimens may be used for screening purposes to determine initially if there is an increase in calcium in the urine.
Chloride	**(Normal values: 20-250 mEq/day)** Chloride is an essential electrolyte. This test is done to determine if there is an imbalance in electrolytes and may be done to diagnose renal tubular acidosis or dehydration, to guide in adjusting fluid and electrolyte balance, to help monitor the effects of reduced salt diets, and to determine the cause of hypokalemia. • Increased values may occur with water loss, head injury (and sodium retention) hypernatremia, renal failure, corticosteroids, dehydration, severe diarrhea (with bicarbonate loss), respiratory alkalosis, diuretics, salicylate toxicity, hyperparathyroidism, metabolic acidosis and use of Kayexalate, acetazolamide, phenylbutazone and ammonium chloride. • Decreased values may occur with Addison's disease, DKA, chronic respiratory acidosis, excess perspiration, vomiting, GI suctioning, diarrhea, Na and K deficiency, metabolic alkalosis, diuretics (loop, osmotic, or thiazide), rapid removal of ascitic fluid, IV fluids (D/W), hear failure, cystic fibrosis, and draining fluids and ileostomies.

	Testing may be done with a random urine sample or a 24-hour collection.

Electrolyte: Magnesium and sodium

Test	Discussion
Magnesium	**(Normal values: 12.0 – 293.0 mg/24 hr.)** Magnesium is a mineral and electrolyte found in the body. About 50% is in the bones and most of the rest is inside body tissues. Only about 1% is in the blood, but this level should remain fairly constant. Magnesium is excreted through the kidneys, so changes in magnesium levels are evident on urine testing. • Magnesium values may be evaluated by both serum and urine testing, but serum testing may be less accurate. • Magnesium urinary excretion is increased with elevated blood alcohol levels, diuretics, Bartter syndrome, corticosteroids, cis-platinum therapy and aldosterone. • Renal magnesium decrease occurs in renal transplant recipients who are on cyclosporine and prednisone. • The ability of the kidney to conserve magnesium is diminished by hypercalciuria, salt-losing conditions, and the syndrome of inappropriate secretion of antidiuretic hormone. • Some drugs affect results. Increases are seen with prolonged salicylate therapy, lithium, and magnesium antacids and laxatives. Decreases are seen with calcium gluconate. Testing is done with a 24-hour urine collection.
Sodium	**(Normal values: 40-220 mEq/24 hr. OR >20 mEq/L for single urine sample)** Sodium is an electrolyte that is critical to maintaining fluid balance within the body. Sodium levels are controlled by aldosterone, an adrenal hormone. About 85% of sodium is found in the blood and lymph. Both serum and urine levels of sodium may be used as when serum levels increase, urine levels often fall, and *vice versa*. Testing is done to evaluate the ability of the kidneys to conserve or excrete sodium: • Increased values are found with water deprivation and dehydration, hypertonic tube feedings, diabetes insipidus, heatstroke, and watery diarrhea. Drugs, such as corticosteroid, sodium bicarbonate, and sodium chloride

	may also cause elevations. • Decreased values are found with diuretic use, renal disease, loss of GI fluids, adrenal insufficiency, SIADH, hyperglycemia, and heart failure. Oxytocin and some tranquillizers may cause fluid retention and decreased values. Testing is done with a 24-hour urine collection (most common) or a single clean catch voided specimen.

Electrolytes: Phosphorus and potassium

Test	Discussion
Phosphorus/ phosphate	**(Normal values: 400-1300 mg/24 hr.)** Phosphorus is a mineral that is found in all body tissues and is essential to the function of muscles, red blood cells and the maintenance of the acid-base balance and the nervous system. Phosphate is the charged ion that contains phosphorus. Phosphorus is necessary to build and repair bones and teeth (about 85% is found in bones). It also has a role in the metabolism of carbohydrate, protein and fat. The kidneys help control phosphate levels. • Decreased values may occur with refeeding after starvation, alcohol withdrawal, DKA, respiratory alkalosis, decreased Mg and K, hyperparathyroidism, vomiting, diarrhea, hyperventilation, malabsorptive disorders with associated vitamin D deficiency, burns, parenteral nutrition, acid-base disorders, and diuretics. • Increased values may occur with acute and chronic renal failure, excess intake of phosphorus or vitamin D, respiratory acidosis, hypoparathyroidism, volume depletion, leukemia/lymphoma treatment, and rhabdomyolysis. Testing is usually done to determine the relationship between phosphorus and calcium and phosphorus and parathyroid hormone. Testing is done with a 24-hour urine collection.
Potassium	**(Normal values: 25-100 mEq/L)** Potassium is both a mineral and an electrolyte. Potassium levels may be evaluated using both serum and urine. When blood levels are high, urine levels are usually low, and *vice versa.*

	• Decreased values are found with diarrhea, vomiting, gastric suction, corticosteroid, hyperaldosteronism, bulimia, osmotic diuresis, alkalosis, starvation, digoxin toxicity, amphotericin B, carbenicillin, and diuretics. • Increased values are found with pseudohyperkalemia, oliguric renal failure, Addison's disease, crush injury, burns, stored bank blood transfusions, rapid IV potassium administration, metabolic acidosis, and the use of potassium-sparing diuretics in those with renal insufficiency. Testing is done with a 24-hour urine collection (most common) or a single clean catch voided specimen.

Urine Tests: A

Test	Discussion
Addis count	**(Normal values: 0-500,000 RBCs, 0-1,800,000 WBCs and epithelial cells, 0-500 hyaline casts.)** The Addis count is done on a 12-hour overnight urine specimen and measures RBCs, WBCs, epithelial cells, and casts. Sometimes protein and specific gravity are measured as well. As preparation for the test, fluids may be restricted in order to concentrate the urine. The Addis test is used to evaluate the progression or renal disease.
Amino acids	**(Values vary)** This test to identify abnormal amino acids in urine is used as an initial screening test for inborn errors of metabolism in cases of suspected genetic abnormalities, such as mental retardation, and reduced growth. It may also be used to diagnose or evaluate acquired conditions, such as endocrine, liver, muscle, neoplastic, and neurological diseases as well as nutritional disturbances, renal failure, and burns. Testing requires a single random voided specimen.
Amylase excretion/ clearance	**(Normal values: 2-3 units/2 hours)** Amylase is one of the digestive enzymes produced by the pancreas and secreted through the pancreatic duct into the intestines to digest carbohydrates. It is also produced by the salivary glands. It is usually only present in serum or urine in small quantities, but if there is disease or injury to the pancreas, increased levels are found in the blood

	and in the urine, where it is excreted. This test is used to differentiate acute pancreatitis from other causes of abdominal pain. Testing requires a 1, 2, or 24-hour urine collection. Two-hour collection is most commonly used.

Tests: B

Test	Discussion
Bence Jones proteins	**(Normal values: 0)** Bence Jones proteins are abnormal free unattached light protein chains that can be found in serum and urine and are associated with multiple myeloma, lymphoma, leukemia, osteogenic sarcoma, and other malignancies. Testing requires a clean catch urine specimen.
Beta-$_2$ microglobin	**(Normal values: <1 mg 24 hours or 0 – 0.3 μg/ml.)** Beta-$_2$ microglobulin is a protein found on the surface of many cells, particularly white blood cells, so increased production or destruction of these cells increases both serum and urine levels. Elevations are commonly found with cancers affecting the white blood cells, such as chronic lymphocytic leukemia, non-Hodgkin's lymphoma, multiple myeloma, and kidney disease. With kidney disease, both serum and urine levels are compared to determine the site of damage. With glomerular disease, the glomeruli can't filter beta-$_2$ microglobulin out of the blood, so serum levels increase and urine levels decrease. With tubular disease, the tubules can't reabsorb it back into the blood, so urine levels increase and serum levels decrease. After a kidney transplant, increased blood levels may indicate and early sign of rejection. Some infections, such as cytomegalovirus also increase levels. Testing requires either a single specimen of urine or a 24-hour collection (most commonly used).
Bilirubin	**(Normal values: Total 0.3 – 1.2 mg/dL Unconjugated<1.1 mg/dL Conjugated <0.3 mg/dL Delta <0.2 mg/dL)**

	Bilirubin is a product of the breakdown of aged red blood cells. Bilirubin is produced in the liver, spleen and bone marrow. Total bilirubin includes unconjugated bilirubin, monoglucuronide, and diglucuronide, conjugated bilirubin, and albumin-bound delta bilirubin. Unconjugated bilirubin is carried to the liver by albumin and converted into conjugated bilirubin. The conjugated bilirubin is converted in the small intestines into urobilinogen and then urobilin, which is excreted in the feces. Increases in bilirubin may occur as the result of prehepatic or posthepatic conditions, so evaluating bilirubin fractions may help to pinpoint the disorder causing increased total bilirubin. For example, delta bilirubin has a longer half-life and remains elevated for longer periods than other fractions. Some drugs increase the amount of bilirubin and may interfere with the test and may be withheld during testing: Allopurinol, barbiturate, birth control pills, some antibiotics, chlorpromazine, diuretics, ethoxazene, phenazopyridine, steroids, and sulfonamides. Other drugs reduce bilirubin levels: indomethacin and ascorbic acid. Urine bilirubin is examined with a 24-hour urine collection.

Urine tests: C-D

Test	Discussion
Creatinine clearance	**(Normal values: 80-120 mL/min.** Creatine is formed when food is metabolized into energy. It is further metabolized to creatinine, which is filtered by the kidneys and excreted in urine. Creatinine is made at a steady rate, but with kidney disease that interferes with excretion, blood levels rise and urine levels fall. The urine creatinine clearance test, which measures how effectively the kidneys remove creatinine from the blood (glomerular filtration rate), is done in conjunction with a creatinine blood test. • Increased clearance values may occur with strenuous exercise, crushing muscle injuries, burns, carbon monoxide poisoning, hypothyroidism, and pregnancy.

	• Decreased clearance values may occur with severe kidney damage related to infection, shock, cancer, low renal blood flow, or urinary tract obstruction. Heart failure, dehydration, and cirrhosis may also cause decreased clearance. **Formula:** (Urine Creatinine / Serum Creatinine) x Urine Volume (ml) / [time (hr.) x 60] = mL/min. Testing is conducted with 12-24-hour urine collection. Strenuous exercise should be avoided for 48 hours prior to testing and meat or other protein (especially beef) should be restricted to ≤8 oz. for 24 hours prior to beginning testing.
Delta-aminolevulinic acid:	**(Normal values: > 6 years = 1.5 – 7.5 mg/24 hours)** This test is used to diagnose lead poisoning and acute intermittent porphyria. Delta-aminolevulinic acid is an enzyme needed for the conversion to porphobilinogen in the metabolic formation of heme (in hemoglobin). Testing requires a 24-hour urine collection.

Urine tests: E-G

Test	Discussion
Estrogens	**(Values vary widely according to age, gender, menstrual cycle, and menopausal state.)** There are over 30 different forms (fractions) of estrogen. Total estrogen is calculated and the most commonly tested fractions include: • ***Estrone*** [E1]: Helps diagnose ovarian tumor, Turner's syndrome, and hypopituitarism. In male, it helps diagnose estrogen-producing tumors and cause of gynecomastia. • ***Estradiol-17 beta*** [E2]: Used to evaluate ovarian function and cause of amenorrhea. It may be used to monitor follicle development in the ovary in the days prior to in vitro fertilization and monitor hormone replacement therapy. It is also used to determine cause of precocious puberty in girls and gynecomastia in men. • ***Estriol*** [E3] (with other tests) is used to assess risk

	of carrying a fetus with abnormalities, such as Trisomy 21 (Down syndrome). A number of drugs may increase estrogen levels, including ampicillin, corticosteroids, tetracycline, and phenothiazines. Clomiphene may decrease levels. Testing is done with a voided specimen of urine.
Follicle-stimulating hormone (FSH) and luteinizing hormone (LH)	**(Normal values:** • **FSH: Men 1-20 IU/24 hr., women 5-20 IU/24 hr., post menopausal women 30-440 IU/24 hr., children (before pubescence) <10 IU/24 hrs.** • **LH: Men 5-20 IU/24 hrs., women 5-15 IU/24 hrs. (follicular phase), post-menopausal women 50-100 IU/24 hr., children (before pubescence) 30-95 IU/24 hr.)** Testing is done to measure gonadotrophic hormone functioning to determine if gonadal insufficiency is primary or related to insufficient stimulation by the pituitary hormones. It is used to evaluate precocious puberty in children and monitor ovulatory cycles in *in vitro* fertilization patients. Evaluation of FSH is used along with other endocrine studies to determine the cause of hypothyroidism in women and endocrine dysfunction in men. • Increased values are found with Turner's syndrome, primary hypogonadism, idiopathic precocious puberty, Klinefelter's syndrome, and menopause. • Decreased values are found with feminizing and masculinizing ovarian tumors, pituitary or hypothalamus failure, anorexia nervosa, neoplasms of testes or adrenal glands that secrete estrogens/androgens, and precocious puberty caused by adrenal tumor. Testing is done with a 24-hour urine collection.

Urine tests: H-J

Test	Discussion

Hemoglobin	**(Normal values: 0)** Hemoglobin, which is attached to red blood cells, does not normally appear in the urine, and when it does it is usually because of disease outside of the urinary system, such as those that cause rapid red blood cell hemolysis. Blood in the urine may be from intact red blood cells (hematuria) or free hemoglobin (hemoglobinuria). Hemoglobinuria can occur with extensive burns and crushing injuries, hemolytic transfusion reactions, malaria, bleeding from prostate surgery, hemolytic disorders such as sickle cell anemia and thalassemia, and disseminated intravascular coagulation. Testing is done with a clean catch voided specimen.
5-Hydroxyindole-acetic acid (5-HIAA)	**(Normal values: 3-15 mg/24 hr.)** Glands in the gastrointestinal tract secrete the hormone serotonin. Serotonin is a vasoconstrictor that is especially useful to small arterioles after tissue injury. It also regulates smooth muscle contraction, such as in peristalsis. The chief metabolite of serotonin, excreted in the urine, is 5-hydroxyindoleacetic acid (5-HIAA). Measuring the serotonin metabolite 5-HIAA in the urine may help in diagnosis of certain gastrointestinal tumors called carcinoid tumors, which cause an increased level of 5-HIAA. • Values >100 indicate a large carcinoid tumor. • Decreased values are found with celiac disease, Whipple's disease, cystic fibrosis, oat cell cancer of bronchus, chronic intestinal obstruction, depressive illnesses, PKU, and severe sciatica with muscle spasms. • False positive may result from foods containing serotonin (bananas, plums, pineapples, walnuts, eggplant, tomatoes, and avocadoes) or drugs (phenacetin, salicylates, reserpine, and methamphetamine). • False negatives may result from other drugs (imipramine, methyldopa, MAO inhibitors, promethazine, phenothiazines, heparins, and ACTH). Testing is done with a 24-hour urine collection.

Hydroxyproline	**(Normal values: 7-43 mg/24 hours)** This test is used to assess the degree of bone and collagen reabsorption in various disorders, such as osteomalacia, and to evaluate the degree of destruction from primary or secondary bone tumors and is also used to measure the severity and response to treatment of Paget's disease of the bone. Levels increase with bone-related disorders or conditions that affect bones, such as osteoporosis, osteomalacia, rickets, prolonged bed rest, pregnancy, multiple myeloma, and acromegaly. Testing is done with 24-hour urine collection.

Tests: K-O

Test	Discussion
17-Ketosteroids (17-KS)	**(Normal values: Men 8-20 mg/24 hr., women 5-15 mg/24 hr., children 0-2 mg/24 hr., elderly 4-8 mg/24 hr.)** 17-KS are metabolites of androstenedione, testosterone, and other compounds. In men, about 33% of 17-KS are of gonadal origin; in women and children, the predominant source is the adrenal gland. This test is used to measure the urinary excretion of steroids and to help diagnose endocrine disorders involving adrenal androgens by assessing the adrenocortical hormone function. • Values increase with pregnancy, adrenal carcinomas, premature infants, Cushing's syndrome, adrenogenital syndrome (associated with adrenal hyperplasia and testosterone administration). • Values decrease with Addison's disease, myxedema, nephrosis, castration, general wasting disease, thyrotoxicosis, and primary ovarian agenesis. Testing is done with a 24-hour urine collection.
Lysozyme	(**Normal values: <4 μg/mL)** Lysozyme, an enzyme, is present in serum, urine, tears, seminal fluid, and breast milk. Serum and urine lysozyme

	levels may be elevated in acute myelomonocytic leukemia (FAB-M4), chronic myelomonocytic leukemia (CMML), and chronic myelocytic leukemia (CML). The test is used most often to differentiate acute myelogenous or monocytic leukemia from acute lymphocytic leukemia. Increased serum lysozyme activity is also present in tuberculosis, sarcoidosis, megaloblastic anemias, acute bacterial infections, ulcerative colitis, regional enteritis, and Crohn disease. Elevated levels of urine and serum lysozyme occur during severe renal insufficiency, renal transplant rejection, urinary tract infections, pyelonephritis, glomerulonephritis, and nephrosis. **Note**: Because of many clinical conditions that can affect test results, this test is primarily used in research settings. Testing is done with a random voided urine specimen.
Oxalate	**(Normal values: males 7.44 mg/24 hr., females 4-31 mg/24 hr.)** Oxalates are organic acids that are found in plants and animals, including humans. Oxalates may be ingested in food or converted from other substances (such as vitamin C) within the body. People who form oxalate kidney stones tend to excrete more dietary oxalate in the urine than others. Additionally, excess excretion is common in those with inflammatory bowel disease (such as those with surgical removal of small intestine from Crohn's disease) or those with jejunoileal bypass for morbid obesity. Testing is done with 24-hour urine collection to determine the potential for developing oxalate kidney stones.

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Tests: P-S

Test	Discussion
Phenylketonuria (PKU):	**(Normal values: Negative finding with reagant strip)** Phenylketonuria (PKU) is a genetic disease in which the enzyme that coverts phenylalanine to tyrosine is lacking, leading to severe mental retardation and brain damage if undetected and treated. This is part of the routine

	screening test done for neonates. Both serum and urine testing may be used. • Premature infants (<5 lb.) may have elevation of levels of phenylalanine and tyrosine without the disease, probably because enzyme has not yet developed. Testing is done with fresh pediatric urine sample, sometimes by pressing reagant strip against wet diaper.
Porphyrin	**(Normal values: 60-200 mg/24 hr.)** Porphyrin, a cyclic compound formed from delta-aminolevulinic acid, is a foundation of heme (the iron-containing non-protein part of hemoglobin) and some enzymes. Excess porphyrins are excreted in the liver and stool. Porphyrias are diseases in which there is overproduction of porphyrin but deficient levels of heme and important enzymes. Porphyrin testing is used specifically to diagnosed porphyrias. Disorders of porphyrin metabolism may be genetic or caused by drugs or lead. Porphyrins, precursors to heme pigment, may cause the urine to appear red. Testing is conducted with 24-hour urine collection.
Pregnancy tests	Human chorionic gonadotropin (hCG), the pregnancy hormone, is only present during pregnancy. It is produced when a fertilized egg implants in the uterus (usually about 6 days after conception). The most accurate results occur ≥7 days after a missed period. These tests are sold over the counter and are used routinely for home pregnancy testing. There are many different types of tests available, and most advise repeating the test for verification. Testing is conducted with random voided urine specimen.
Pregnanediol:	**(Normal values: Men 0-1 mg/24 hr., pregnant women 6-100 mg/24 hr., postmenopausal women 0.2-1mg/24 hr., women follicular 0.5-1.5 mg/24 hr., children 0.4-1.0 mg/24hr)** Pregnanediol is a metabolite of progesterone, excreted in the urine. Pregnanediol measurement allows indirect measurement of progesterone, which is produced by the corpus luteum after ovulation, by the adrenal cortex, ad

	by the placenta during pregnancy. • Increased values may occur with luteal ovarian cysts, hyperadrenocorticism, pregnancy, and malignant neoplasm of trophoblast. • Decreased values may occur with amenorrhea, impending abortion, fetal death, toxemia, neoplasm of ovary, and ovarian tumor, hydatidiform mole. This test measures ovarian and placental function and is indicated for suspected deficiency of progesterone. Testing is conducted with a 24-hour urine collection.
Pregnanetriol:	**(Normal values: <Adults 3.5 mg/24 hr., children <6 years ≤0.2mg /24 hr., children >6 years 0.3-1.1mg/24 hr.)** Pregnanetriol is a urinary metabolic of 17-α-hydroxyprogesterone and a precursor in cortisol biosynthesis. Diseases of the adrenal cortex or corticotropin administration may increase its excretion in the urine. Increased levels may occur with adrenogenital syndrome and insufficient dosage of cortisol. The test used to diagnose adrenocortical dysfunction and adrenogenital syndromes. Testing is conducted with a 24-hour urine collection.

Urine tests: T-U

Test	Discussion
Tubular phosphate reabsorption:	**(Normal values: >80% reabsorption)** The parathyroid glands secrete parathyroid hormone (PTH), which functions to maintain normal serum calcium and phosphate concentrations. Changes in production of PTH affect the rate of phosphate and calcium reabsorption in the tubular system of the kidney. This test is used to diagnosis hyperparathyroidism. The urine test must be done along with a blood test. • Increased rate of reabsorption may indicate myeloma, osteomalacia, renal tubular disease, sarcoidosis, and uremia. • Decreased rate (<74%) suggests

	hyperparathyroidism). Some drugs may affect test results: Amphotericin-B, chlorothiazide diuretics, furosemide, and gentamicin. A normal phosphate diet (avoiding excessive consumption of high phosphate foods) should be eaten for 3 days prior to the test with fasting the night before the test. Urine collection begins immediately after blood test. Testing is done with a 24-hour urine collection.
Uric acid	**(Normal values: 250 to 750 milligrams per 24 hours.)** Uric acid may be evaluated by serum or urine testing. Uric acid is produced from the natural breakdown of cells and foods that contain purine. Normally, most uric acid is excreted in the urine, so if uric acid levels rise, then levels in the urine increase also. If the kidneys are unable to remove the uric acid, serum levels increase while urine levels decrease. Uric acid levels rise markedly with gout, leading to development of uric acid crystals in joints and nearby tissue. High urine levels of uric acid can lead to kidney stone formation. Testing is done to help determine the cause of increases in serum uric acid and to determine if kidney stones are caused by high uric acid levels in the urine. Testing requires a 24-hour urine collection with restriction of alcohol during collection (as that lowers uric acid levels).
Urobilinogen	**(Normal values 0.1 – 1.0 units)** Bilirubin is formed from the breakdown of hemoglobin (heme portion) from aging red blood cells in the liver, spleen and bone marrow. Unconjugated bilirubin is carried to the liver by albumin, where it becomes conjugated. It is then carried by bile into the small intestines where it converts to urobilinogen and then urobilin, which is excreted in the feces. Some of the urobilinogen is reabsorbed into the blood and filtered through the kidneys, entering the urine. Urobilinogen levels in the urine are usually very low but can increase with liver diseases, such as cirrhosis and hepatitis, and blood diseases that increase the rate of RBC destruction, such as hemolytic anemia.

	Urobilinogen values decrease with biliary obstruction, which prevents the conjugated bilirubin from reaching the intestines for conversion to urobilinogen (and concurrently there is an increase in circulating bilirubin and excretion of bilirubin by the kidneys). Some drugs, such as ammonium chloride or ascorbic acid may decrease levels. Testing is done with a fresh voided sample using a reagent stick.

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Urine tests: V-Z

Test	Discussion
Vanillylmandelic acid (VMA)	**(Normal values: 1.8 – 6.7 mg/24 hr.)** VMA is a metabolite of urinary catecholamines, formed by the adrenal medulla and excreted in the urine. Catecholamines increase heart rate, blood pressure, breathing rate, muscle strength, and mental alertness and lower the amount of blood going to the skin and increase blood going to the major organs, such as the brain, heart, and kidneys. Some disorders increase the levels of catecholamines. This test is used to evaluate the presence of pheochromocytoma, a tumor of the adrenal medulla, and neuroblastoma. Dietary restrictions for 2-3 days prior to beginning testing include caffeine, amines (bananas, walnuts, avocados, fava beans, cheese, beer, and wine), vanilla, and licorice. Aspirin, antihistamines, and diet pills are restricted for 2 weeks before testing, and no tobacco should be used during urine collection. Testing is done with 24-hour urine collection. If 24-hour collection is difficult, as with pediatric patients, a single random voided specimen may be used.

Conclusion

The kidneys are one of the primary excretory organs of the body. The kidneys maintain the internal environment of the body by selectively excreting or retaining

various substances. The nephron, comprised of the glomerulus, Bowman's capsule, and the tubular system, is the kidney's primary functional unit. Urine is a byproduct of kidney functions that include waste excretion, maintenance of electrolyte balance, acid excretion, and water excretion and reabsorption. The urinalysis is a non-invasive test that provides diagnostic information about many diseases. Urinalysis is done with direct observation, dipstick analysis, and microscopic analysis.

There are a number of different types of urine specimens: random voided, first morning specimen, double-voided, clean catch, catheterized, suprapubic transabdominal needle aspiration, timed collection (2-72 hours), and pediatric collection. Normal volume is 750-2500 mL/24 hours. Normal specific gravity is 1.001-1.040 and normal pH is 4.5-8. Otherwise, a normal urinalysis should be negative for all other factors (such as glucose, ketones, proteins). The color of urine may change because of different disorders, drugs, foods, and level of hydration. Some tests, such as nitrite and leukocyte esterase are indirect measures of infection as they may increase with bacterial infection. Microscopic examination of sediment in urine may identify cells, microorganisms, spermatozoa, mucus, casts, and crystals.

There are many associated urine tests that measure for levels of electrolytes, enzymes, hormones, and other substances to help diagnose a variety of conditions, including pregnancy.

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