

## Urine Analysis

### Introduction:

A urinalysis is a group of tests that detect and semi-quantitatively measure various compounds that are eliminated in the urine, including the byproducts of normal and abnormal metabolism as well as cells, including bacteria, and cellular fragments.

Urine is produced by the kidneys, located on either side of the spine at the bottom of the ribcage. The kidneys filter wastes and metabolic byproducts out of the blood, help regulate the amount of water in the body, and conserve proteins, electrolytes, and other compounds that the body can reuse. Anything that is not needed is excreted in the urine and travels from the kidneys to the bladder, through the urethra, and out of the body. Urine is generally yellow and relatively clear, but every time someone urinates, the color, quantity, concentration, and content of the urine will be slightly different because of varying constituents.

Many disorders can be diagnosed in their early stages by detecting abnormalities in the urine. These include increased concentrations of constituents that are not usually found in significant quantities in the urine, such as: glucose, protein, bilirubin, red blood cells, white blood cells, crystals, and bacteria. They may be present because there are elevated concentrations of the substance in the blood and the body is trying to decrease blood levels by “dumping” them in the urine, because kidney disease has made the kidneys less effective at filtering, or in the case of bacteria, due to an infection.

A complete urinalysis consists of three distinct testing phases:

1. Physical Examination: which evaluates the urine's color, clarity, and concentration.
2. Chemical Examination: which tests chemically for 9 substances that provide valuable information about health and disease.

3. Microscopic Examination, which identifies and counts the type of cells, casts, crystals, and other components (bacteria, mucous ) that can be present in urine.

Usually, a routine urinalysis consists of the physical and the chemical examinations. These two phases can be completed in just a few minutes in the laboratory or doctor's office. A microscopic examination is then performed if there is an abnormal finding on the physical or chemical examination, or if the doctor specifically orders it.

### **How is the sample collected for testing?**

Urine for a urinalysis can be collected at any time. The first morning sample is the most valuable because it is more concentrated and more likely to yield abnormal results. Because of the potential to contaminate urine with bacteria and cells from the surrounding skin during collection (particularly in women), it is important to first clean the genitalia. As you start to urinate, let some urine fall into the toilet, then collect one to two ounces of urine in the container provided, then void the rest into the toilet. This type of collection is called a midstream collection or a clean catch.

### **When to get tested?**

During a routine physical or when you have symptoms of a urinary tract infection, such as abdominal pain, back pain, frequent or painful urination, or blood in the urine; as part of a pregnancy checkup, a hospital admission, or a pre-surgical work-up

Examination of urine may be considered from two general points:

1. Diagnosis and management of renal or urinary tract disease.
2. The detection of metabolic or systemic diseases not directly related to the kidney.

### **How is it used?**

The urinalysis is used as a screening and/or diagnostic tool because it can help detect substances or cellular material in the urine associated with different metabolic and kidney disorders. It is ordered widely and routinely to detect any abnormalities that

should be followed up on. Often, substances such as protein or glucose will begin to appear in the urine before patients are aware that they may have a problem. It is used to detect urinary tract infections (UTI) and other disorders of the urinary tract. In patients with acute or chronic conditions, such as kidney disease, the urinalysis may be ordered at intervals as a rapid method to help monitor organ function, status, and response to treatment.

### **When is it ordered?**

A routine urinalysis may be done when you are admitted to the hospital. It may also be part of a wellness exam, a new pregnancy evaluation, or a work-up for a planned surgery. A urinalysis will most likely be performed if you see your health care provider complaining of abdominal pain, back pain, painful or frequent urination, or blood in the urine, symptoms of a UTI. This test can also be useful in monitoring whether a condition is getting better or worse.

### **What does the test result mean?**

#### **NOTE:**

A standard reference range is not available for this test. Because reference values are dependent on many factors, including patient age, gender, sample population, and test method, numeric test results have different meanings in different labs. Your lab report should include the specific reference range for your test.

Urinalysis results can have many interpretations. They are a red flag, a warning that something may be wrong and should be evaluated further. Generally, the greater the concentration of the abnormal substance (such as greatly increased amounts of glucose, protein, or red blood cells), the more likely it will be that there is a problem that needs to be addressed. But the results do not tell the doctor exactly what the cause of the finding is or whether it is a temporary or chronic condition. A normal urinalysis also does not guarantee that there is no illness. Some people will not release elevated amounts of a substance early in a disease process and some will

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release them sporadically during the day (which means they may be missed by a single urine sample). In very dilute urine, small quantities of chemicals may be undetectable.

The urinalysis is a set of screening tests that can provide a general overview of a person's health. Your doctor must correlate the urinalysis results with your health complaints and clinical findings and search for the causes of abnormal findings with other targeted tests (such as a comprehensive metabolic panel (CMP), complete blood count (CBC), or urine culture (to look for a urinary tract infection)).

### **Precautions:**

A urine sample will only be useful for a urinalysis if it is collected as a clean catch and taken to the doctor's office or laboratory for processing within a short period of time. If it will be longer than an hour between collection and transport time, then the urine should be refrigerated.

### **Collection of Urine:**

The urine sample must be collected in a clean, dry container and should be examined when freshly voided. Red cells, leukocytes and casts decompose with time. Bilirubin and urobilinogen will decrease especially with exposure to light. Glucose is utilized by bacteria and cells; ketones are utilized or volatilized. Bacterial contamination usually occurs resulting in alkalization of the urine owing to the conversion of urea to ammonia. Turbidity develops as bacteria multiply and alkaline precipitates. The colour will change (darkens) and the odour becomes offensive.

### **Collection of Urine for Screening Purposes:**

For chemical and microscopic examination a voided specimen is usually suitable. The first morning specimen of urine is the most concentrated specimen and its specific gravity reflects the concentrating power of the kidney and it is suitable for examination of urine for proteins and nitrite.

### **Collection of Urine for Quantitative Analysis:**

Because substances such as hormones, protein and electrolytes are variably excreted during a day, 24 hours collection is used for comparison.

- Errors in the results of quantitative urine tests are most often related to collection problems.
- The adequacy of 24 hours collection has been related to the creatinine excretion.
- Specifications relating to each assay must be given in printed instructions. Certain foods and drugs may have to be withheld.

The patient is instructed to empty his bladder at 08.00 am (or a suitable time on rising) and to discard this urine. He collects all subsequent urine up to and including that at 08.00 am the following morning. The total volume is measured and recorded. The urine is thoroughly mixed before a measured sample is withdrawn for analysis.

### **Containers:**

- Disposable plastic container 100-200 ml with screw caps is preferred for routine screening analysis.
- Rigid brown plastic containers 3000 ml with wide mouths and screw caps are suitable for 24 hours collection.
- Polyethylene bags are used for pediatric urine collections. An estimate of the volume can be made. The bag may be sealed for transportation.
- Sterile plastic containers are used when cultures are to be made.

### **Storage and Preservation:**

Random specimens for routine analysis should be examined fresh, within one hour after voiding or refrigerated and examined as soon as possible. Freezing is used for aliquots of urine for quantitative chemical tests.

### **Formalin:**

Cells and casts may be preserved by rinsing the empty container with formalin prior to use but it interferes with tests for sugar.

### **Thymol:**

One crystal of thymol per 10 to 15 ml will preserve sediments but interferes with test for bile salts and bile pigments. Toluene and chloroform are usually not desirable, chloroform mixes with the deposit.

### **Sodium fluoride:**

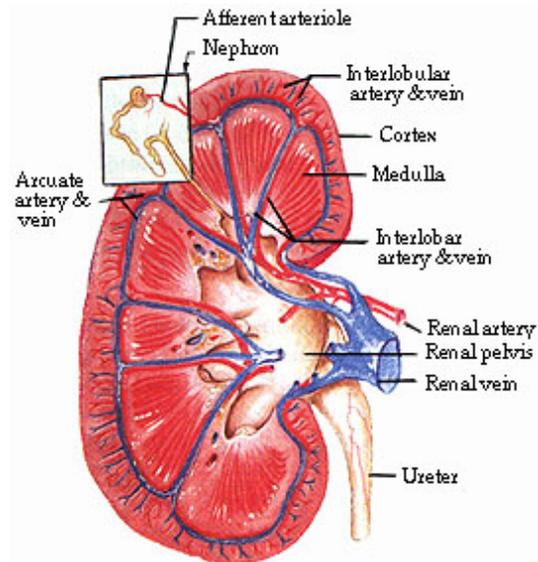
Glucose in 24 hour urine collections is preserved by using sodium fluoride (0.5 g) it may inhibit the reagent strip test for glucose. It does not inhibit the qualitative copper reduction tests (Benedict). Xylose in urine may be preserved with sodium fluoride.

### **pH Adjustment:**

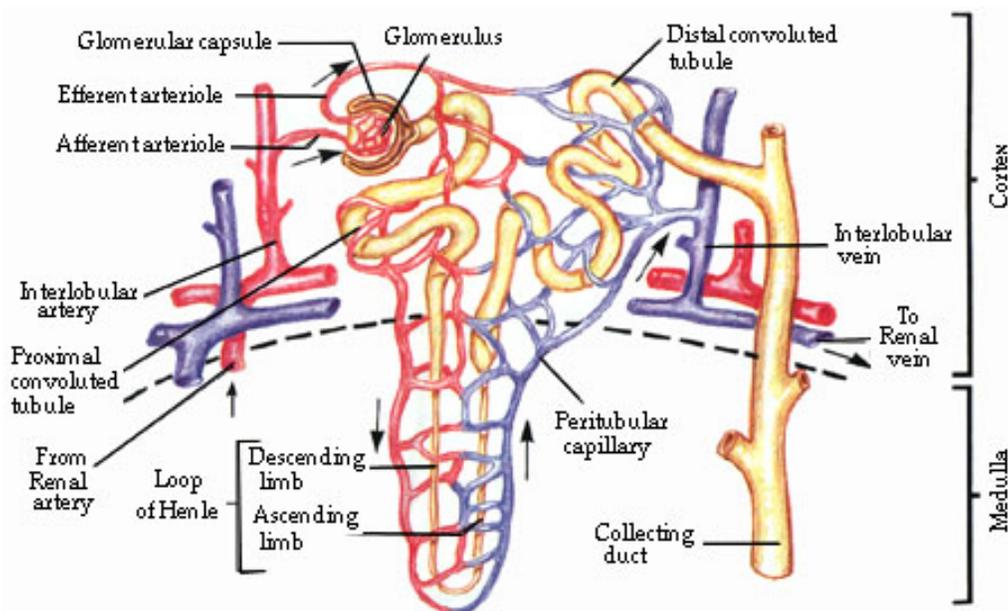
A very low pH (<3) will prevent bacterial growth and stabilize substances such as catecholamines or V.M.A. (vanillylmandelic acid) or 5-HIAA (5-hydroxy indole acetic acid) and ketosteroids. 10 ml of concentrated HCl or 20 ml of 6N HCl are used. Urine for 24 hour estimations of porphyrins, porphobilinogen and delta amino levulonic acid is collected and adjusted to a pH of 6 to 7 with acetic acid or sodium carbonate. Dark containers are preferred; the collection is refrigerated between voiding.

## Review of Renal Physiology

The main function of the kidneys is the excretion of urine. The functional unit of the kidney is the nephron. There are approximately one million nephron in each kidney at birth which declines to about 600,000 in old age. Approximately 20-25 % of the blood volume or 1200 c.c. of blood, 600 c.c. of plasma/min flows through the kidney. Thus in 4-5 minutes, the total blood volume passes through the renal circulation.



The blood goes to the glomerulus, which is essentially a filtering system, through the afferent arteriole. As a result of filtration, the blood is more concentrated when it leaves the glomerulus in the efferent arteriole. Its protein content increased, and, therefore, its osmotic pressure is greater.



The glomerular ultrafiltrate contains many substances necessary for normal metabolism, such as water, glucose, amino acids and electrolytes, as well as

substances to be excreted or removed, such as urea, creatinine and uric acid. Sixty to 80 % of the glomerular ultrafiltrate is normally reabsorbed by the proximal tubule. Water (80-90%), calcium, sodium chloride, phosphate, amino acids and glucose diffuse uric acid passively in the cell from the tubular lumen.

The fluid then passes into the loop of Henle, which is composed of:

- The descending limb: more permeable to water than to solute.
- The ascending limb: impermeable to water, freely permeable to sodium chloride and partially permeable to urea.

The fluid then enters the distal tubule. Of the 10% of water remaining much is reabsorbed as a result of the action of antidiuretic hormone (ADH) elaborated by the posterior lobe of the pituitary gland, except for 1% or 2%. This small fraction of the glomerular ultrafiltrate flows into the urinary bladder as urine.

### **Diuresis:**

The increased secretion of urine is brought about chiefly by a failure of the tubules to reabsorb their usual quota of the glomerular filtrate. The **Diuretic substance** is that which prevents the absorption of sodium salts and hence of water, presumably by the action on the enzymes in the tubular cells.

**Na salts and urea exert diuretic effects** Because after they are filtered through the glomerulus they increase the osmotic pressure to such an extent that less filtrate is reabsorbed by the tubules.

## Physical Characteristics of The Urine

### Volume:

The normal 24-hour urine volume of an adult is between 600-2000 ml. It varies greatly with the fluid intake (which is usually a matter of habit) and on the loss of fluid by other routes (sweating due to physical activity and external temperature). The volume of urine is less in summer than in winter.

- **Oliguria (<500 ml):** deficient urine secretion develops in dehydration, urinary tract obstruction, as well as non-renal disease due to deficient intake of water and excessive loss of fluid by other routes, for example by hemorrhage, vomiting and diarrhea.
- **Anuria:** is the cessation of secretion of urine by the kidneys.
- **Polyuria or Diuresis:** excessive excretion of urine develops in diabetes insipidus, hysterical polydipsia, increased salt intake, and high protein intake and in any disease where there is an increased excretion of metabolites.
- **Nocturia:** increased flow of urine at night (an early symptom of kidney disease) over 500 ml of urine of specific gravity 1.018 passed at 12 hrs night period.

### pH:

On a normal mixed diet the urine is usually acid (~ 6).

- A vegetarian diet causes a tendency to alkalosis, thereby produces alkaline urine, since the oxidation of food produces salts of inorganic acids as sodium lactate and sodium iodate.
- Urine pH decreases after a meal because of the increased secretion of HCl into the stomach for digestion.
- When the protein intake is high, the urine is usually acid since the oxidation of S-containing amino acids produces  $H_2SO_4$  and  $H_3PO_4$ .

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- Alkaline urine occurs in renal diseases such as chronic glomerulonephritis because of decreased glomerular filtration, which causes a diminished excretion of phosphate, sulfate and other acid buffers.
- Urine pH decreases at the early morning or after any fairly prolonged period of sleep because of the mild respiratory acidosis occurring with sleep and the renal compensation to that acidosis.
- The normal urine becomes alkaline on standing because of the conversion of urea to ammonia by bacterial action.

### Colour:

The colour of the urine is affected by many components (concentration, food pigments, dyes, medication, and blood). The intensity of the colour of normal urine is dependent on the concentration of the urine. The yellow or amber colour of normal urine is due to the presence of a yellow pigment, urochrome. Usual causes of urinary colours are shown in the following table.

<b>Colour</b>	<b>Cause</b>
Yellow green	Bile pigments (as in jaundice).
Colourless	Reduced concentration (diabetes mellitus).
Whitish turbid	Pus, bacteria or epithelial cells.
Red brown	Hemoglobin (hemolysis and hemoglobinuria).
Red	Blood (hematuria) in kidney damage or schistomiasis, medication (antibiotic or anticoagulant therapy) or eating beetroot.
Pinkish brown	Urobilin (hemolytic anemia).
Yellow foam	Bile or medication.
Orange	Riboflavin (vitamin therapy) or eosin (colouring agents in sweets).
Black	Iron sorbitol (parenteral iron therapy).

### **Appearance:**

The normal urine is usually clear or slightly turbid but it becomes cloudy in alkaline and acidic urine due to the precipitation of calcium phosphates (white) in the former and of urates (pink colour) and oxalates in the latter. In pathological urine the cloudiness is due to the presence of bacteria and pus.

### **Smell or Odour:**

Fresh urine is usually aromatic. On standing the decomposition of urea causes the odour to become ammonical. In ketosis, the odour of acetone may be detected (fruity odour).

### **Urine concentration (Specific gravity):**

The urine specific gravity can be defined as a comparison of the weight of urine with the weight of an equal volume of distilled water. It can also be defined as a measurement of density, which depends not only on weight but also on the number of solute particles in solution.

The specific gravity of urine indicates the relative proportion of dissolved solid components to the total volume of the specimen. It reflects the relative degree of concentration or dilution of the specimen and measures the concentrating and diluting abilities of the kidney. Normal specific gravity: 1.015-1.025. It is highest in the first morning specimen.

A low specific gravity may suggest kidney disease, the damaged kidney tubules being unable efficiently to remove the waste products of metabolism, such as urea from the blood. These results in a less concentrated urine and raised blood urea.

A high specific gravity often suggests diabetes mellitus, a disease in which there is an increase of sugar in the blood. This passes into the urine, increasing its concentration. The specific gravity is increased if there is protein in the urine.

### **Total solids:**

The total solids are determined in g/l by multiplying the last two figures of the specific gravity by Long's coefficient.  $2.66 \times \text{Sp. Gr.} = \text{g/l.}$

## Chemical Characteristics of the Urine

### Proteinuria:

Proteinuria refers to an abnormally increased amount of proteins in the urine. Measurement of urinary protein level is an important evaluation of glomerular function:

**a. Functional Proteinuria:** The presence of small amounts of protein without any other impairment of renal function (severe stress, excessive exercise, and severe dehydration because of the increased concentration of solute in solution and in the latter stage of pregnancy).

**b. Organic Proteinuria:**

- 1- **Pre-renal:** This is caused by a general disease, which affects the kidneys and is an indication of renal damage, such as essential hypertension.
- 2- **Renal:** All types of renal diseases will cause proteinuria (acute nephritis, chronic nephritis and nephrotic syndrome).
- 3- **Post-renal:** This case may be due to lesions in the renal pelvis, bladder, prostate and urethra. It may also be caused by bacterial infection of the urinary tract. These patients usually have pain on passing urine (**dysuria**). When a patient has any kind of urinary infection, protein and pus cells (**pyuria**) can be usually found in the urine.

### Glucosuria:

A 24 hours specimen of urine from a normal subject contains a small amount of reducing substances, generally less than 1 g, of which 20-200 mg is glucose. Glucosuria implies that sufficient glucose is present to be detectable by a simple clinical test. The traditional test employed is Benedict's solution, which is blue because of the presence of  $\text{Cu}^{+3}$  ions. On reduction of Benedict's solution by glucose or other reducing substances, the blue colour disappears and an orange-red precipitate of  $\text{Cu}^{+2}$  oxide is formed. The causes of glucosuria may be summarized as:

- **Low renal threshold:** This leads to renal glucosuria; occurs with normal blood glucose level but tubular reabsorption of glucose is below normal thus permitting some glucose to spill into the urine.
- **Hyperglycemia with impaired glucose tolerance:** This leads to Diabetes mellitus; a pathologic state associated with increased blood sugar and polyuria. The urine is colourless due to diluted polyuria and of high specific gravity due to extra load of dissolved solids (glucose). Hyperglycemia without glucosuria may be found if there is a raised threshold due to diminished renal plasma flow, this is quite often seen in elderly diabetic.

### Other sugars:

Lactose, fructose, galactose and pentoses are other reducing sugars, which may be found in urine.

**Lactose:** This is often present in the urine of pregnancy after 20 weeks. It usually occurs in nursing mothers (during lactation). It is occasionally found in patients on a milk diet (in case of liver cirrhosis).

**Galactose:** Galactosuria occurs usually inferior to Galactosemia, which occurs as a congenital abnormality. It is due to deficiency of the hepatic enzyme galactose-1-phosphate uridyl transferase, which is concerned, with the conversion of galactose to glucose. Accumulation of galactose-1-phosphate leads to renal tubular damage with aminoaciduria, proteinuria, acidosis and liver damage with jaundice. The high blood galactose leads to cataracts.

**Fructose:** Congenital fructosuria is usually due to the deficiency of an isoenzyme of aldolase. Fructose-1-phosphate accumulates after ingestion of fructose or sucrose and this causes hypoglycemia and liver damage.

**Pentose:** Pentosuria occurs usually after ingestion of large amounts of pentose-containing fruits. Congenital pentosuria due to L-xylulose reductase deficiency is less rare.

Identification of sugars other than glucose is performed by thin-layer chromatographic separation methods.

### **Ketonuria:**

The body normally metabolizes fat completely to CO<sub>2</sub> and H<sub>2</sub>O, so that only 3-15 mg of ketones is excreted daily which cannot be qualitatively detected in urine. Whenever there is inadequate carbohydrate in the diet or a defect in carbohydrate metabolism (e.g. in diabetes mellitus) the body metabolizes increasing amounts of fatty acids. When this increase is large, fatty acid oxidation is incomplete and intermediates products of fat metabolism appear in the blood (ketonemia) and are excreted in the urine (**ketonuria**). These intermediary products are acetoacetic acid, acetone and B-hydroxybutyric acid. Ketonemia and ketonuria also develop when the patient is suffering from carbohydrate deficiency. Thus ketonuria is found in starvation or on a badly balanced reducing diet. Postoperative ketonuria is commonly seen. It is due to a combination of the starvation that precedes the operation, the vomiting that often follows it and possibly to the effect of anaesthesia which depletes liver glycogen.

### **Hemoglobinuria:**

Intravascular hemolysis (lysis of red blood corpuscles) from any cause liberates hemoglobin into the circulation. Haptoglobins are specific  $\alpha_2$ -globulins that bind hemoglobin at the globin. The function of haptoglobins is to conserve iron after intravascular hemolysis by binding to hemoglobin.

Haptoglobin bound to hemoglobin is taken up mainly in the liver; the haptoglobin is slowly resynthesized and the iron reticulates from hemoglobin that is then released. When the plasma hemolysis exceeds 100mg %, hemoglobin is released into the surrounding medium, enters the glomeruli and appears in the urine.

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Condition	Cause of hemoglobinuria
1. Intravascular hemolysis of exercise	<ul style="list-style-type: none"><li>• Strenuous exercise by athletes.</li><li>• Hemoglobinuria may occur after a brief run or walk.</li></ul>
2. Chemical agents acting directly on red cells.	Some chemical agents as arsine, sulfonamides, phenylhydrazine, and naphthalene produce acute hemolytic anemia with fragmentation and increased osmotic fragility of red cells.
3. Infestation of red cells.	<ul style="list-style-type: none"><li>• In severe malaria, marked infestations of red cells by the plasmodium may be associated with hemoglobinuria.</li><li>• In Oroya fever, the red cells are infested by <i>Bartonella bacilliformis</i>.</li></ul>
4. Favism	Sensitivity to the fava bean may result in severe hemolytic anemia through glucose 6-phosphate dehydrogenase deficiency.
5. Wrong blood transfusion	
6. Toxins	Snake and spider bites.
7. Thermal injury	As in burns.
8. Intravascular hemolysis	Resulting from hepatotoxicity of plasma, as in intravenous injection of Dist H <sub>2</sub> O will cause hemoglobinemia and hemoglobinuria.

### Hematuria:

It is characterized by the presence of hemoglobin and unruptured red blood corpuscles. It is caused when blood passed into the urine through some lesions of the kidney or the urinary tract. When the red blood cells enter the urine hemolysis usually occurs after a short time.

### Bile pigments:

The main pigments excreted in the urine are bilirubin and urobilinogen.

**Normal cycle:** when Hb is released, the globin portion is separated and the iron released from the heme becomes bound to transferrin; it is not excreted but enters the iron store or is used for further Hb synthesis. The catabolism of porphyrin rings takes place in the reticuloendothelial cells of spleen. The bilirubin formed passes into the

blood stream and is bound to albumin then transported to the liver as **indirect bilirubin**.

In the liver cells, the bound bilirubin is separated and instead conjugated with glucuronic acid forming **conjugated or direct bilirubin** and is secreted in the bile and then through the bile duct into the intestine. **In the intestine** the glucuronides are removed and bilirubin is reduced to a group of colourless urobilinogen by intestinal bacteria. **Most of the urobilinogen** is excreted in the feces where it is oxidized by air to a pinkish-brown Urobilin pigment. **A small fraction of the urobilinogen** is absorbed into the portal circulation and in the liver some of this urobilinogen is reexcreted into the bile, while the remainder is excreted by the kidneys. Normally between 1-4 mg of urobilinogen is excreted in the urine per day. Therefore, in normal urine there should be no bilirubin and only small amounts of urobilinogen, unless the bilirubin cycle is abnormal as in the following diseases:

- **Obstructive jaundice:** in which the bilirubin cannot leave the liver because the bile duct leading to the intestine is blocked. The bilirubin is absorbed into the circulation and passes into the kidneys. If the blockage is complete no urobilinogen can be formed. Therefore there will be bilirubin in the urine with normal amounts or no urobilinogen in the urine.
- **Hemolytic jaundice:** in which increased amounts of bilirubin are formed because large numbers of red corpuscles are haemolysed, as in sickle cell anemia, malaria, or other forms of hemolytic anemia. Not all the bilirubin formed becomes water-soluble in the liver, and the excess is absorbed into the plasma. Therefore there will be no bilirubin in the urine with increased or normal amounts of urobilinogen.
- **Hepatic jaundice:** this type is caused by viral infection, which damages the liver cells. This may prevent the liver cells from passing on the bilirubin into the intestine, especially in the later stages of the disease, and the bilirubin is, therefore, absorbed into the circulation as unconjugated bilirubin. Later in the disease, the urobilinogen, which returns to the liver, cannot be passed on by the damaged cells

and is, therefore, absorbed back into the circulation to be excreted in the urine. Therefore there will be bilirubin in the urine in the early stages of the disease with increased amounts of urobilinogen in the later stages of the disease and normal or reduced amounts in the early stages.

### **Bile salts:**

Human bile contains 4 bile acids, cholic acid, deoxycholic acid, chenodeoxycholic acid and lithocholic acid. They are synthesized in the liver from cholesterol. Only small amounts of bile acids are found in the free state. The major part is conjugated through amide linkages with glycine and taurine. The conjugated bile acids are neutralized by  $\text{Na}^+$ ,  $\text{K}^+$  giving glycocholates and taurocholates (bile salts). Bile salts in the intestine are necessary for absorption of fats. Bile salts have a hydrotropic behavior; have a powerful capacity of lowering surface tension rendering certain substances soluble in water in which otherwise they would be insoluble, facilitating the close contact between fat and water-soluble lipase.

## **Microscopical Characteristics of the Urine**

The following may be found in urine deposits:

### **Pus cells:**

Pus cells are polymorphs leukocytes which have come from the blood to fight bacteria invading the urinary tract. They have a nucleus with several segments, which can often be seen with the High power objective. As pus cells are broken down in the urine, their nuclei disappear and only the cell membranes remain. Five pus cells per  $\text{mm}^3$  is a common figure. Patients with pus cells more than 5 per  $\text{mm}^3$  are thought to have a urinary tract infection. Also the patients who have infections in the vagina and urethra have discharge from these organs called pus (Pyuria). These discharges contain protein and may contain pus cells and red cells.

### **Red blood cells (Erythrocyte):**

Red cells do not contain granules, and so can be distinguished from pus cells. They also have a clearly seen outline, and are usually smaller. Red cells are not normally seen in urine, but may be present in urinary infections, tumors and calculi. Red blood cells can come from any part of the urinary system from the glomerulus to the urethral meatus and may be a contaminant during menstruation in the urine of women. Therefore, the significance of red blood cells (hematuria) must be related to the other findings in the urinary sediment. If there is enough blood in the urine it will be turbid (smoky). Red cells are sometimes destroyed in the circulation and hemoglobin rather than red cells may be passed into the urine (hemoglobinuria). The urine will be clear and red.

### **Epithelial cells:**

These are flat large cells with a nucleus that can usually be seen quite easily. They come from the epithelial (skin) on the side of the ureters, bladder, vagina and urethra. Epithelial cells are usually singles that is there is one cell at a time. A few epithelial cells are found in normal urine.

**Casts:**

These are solid substances (proteins or remains of the dead cells in kidney diseases) blocking the kidney tubule and becomes loose and goes down into the urine. Because it was found inside the tubule a cast has the shape of the tubule from which it came. Casts can be of different types as follows:

- **Cellular casts:** which are often seen in the urine of jaundiced patient due to increased red cell destruction. They are yellow-brown.
- **Granular casts:** when seen, indicate renal dysfunction. They are usually dark in colour and contain small granules. Granular casts consist of antigenic protein granules. These protein granules appear to represent fragments of parent serum proteins. They are found when there is protein in the urine. All urine showing ++ proteinuria should be examined for granular casts.
- **Hyaline casts:** they are clear, colourless and have no granules in them. They dissolve in alkaline urine. They are the proteins left when water is reabsorbed in the tubule. Normal urine often has some of these casts, and they do not mean that the kidney is diseased.

**Crystals and other material:**

**Acidic urine:**

Crystals	Characteristic appearance	Clinical significance
Uric acid	Yellow brown rhombic crystals, some with pointed ends.	Normal or gout
Calcium oxalate	Octahedral envelope and dumbbell forms.	Normal, ethylene glycol poisoning.
Sodium urate	Amorphous or crystal needles.	<i>Normal</i>
Calcium and magnesium urate	Amorphous.	<i>Normal</i>

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### Alkaline urine:

Crystals	Characteristic appearance	Clinical significance
Calcium hydrogen phosphate	Amorphous, irregular colourless plates.	Normal
Amm. Mg phosphates (triple phosphates)	Coffin lids, square prisms.	Normal

### Bacteria:

Normal urine contains no bacteria. However, bacteria often grow in normal urine if it is left in warm room. They got into the urine from a dirty jar, from the air or from the patient's skin. Finding bacteria in old urine means nothing but in fresh urine means that the patient has a urinary infection. Usually there will be pus cells and protein present also. A common kind of bacteria found in the urine is called *E. coli*. It is a thin motile rod like a very small pencil.

### Yeast and Fungi:

The threads or mycelium of a mould or a fungus are longer and thicker than a bacterium and they branch. When yeasts grow, a parent cell often makes a daughter cell, which is smaller and grows from one end.

### Spermatozoa:

They are the male sex cells. They are often found in the man's urine and are quite normal. After sexual intercourse they may be found in a woman's urine. Spermatozoa should be reported when present in large amounts, which may suggest a lesion in genito-urinary tract.

### Parasites:

In some parts of the world especially tropical countries, one of the most parasites are the ova of a worm called *Schistosoma haematobium* which lives in the veins of the walls of bladder and ureters. The worm lays eggs that go through the side of the bladder into the urine. The disease that it causes is called Schistosomiasis or bilharziasis. With the ova in the urine there are usually also protein, red cells and pus cells. When you are looking for the ova of *S. haematobium* you should take a

specimen that has been passed by the patient between midday and two in the afternoon.

### **Movement:**

You will see three kinds of movement in a wet film of urine, stool or blood. The first kind is the movement of microorganisms themselves, called motility. Motile bacteria like *E. coli* can be seen swimming from one place in the field to another; while everything else stays still. The second kind of movement is called Brownian movement. If you look at any very small particle lying free in a liquid, you will see that it is always moving and is never quite still. Their movements are very small and quite fast, the particles seen to shake about only. The third kind of movement is called streaming. You will see a stream or river of particles moving in the same direction.

## Common Questions

### **How long does it take to get results for urinalysis?**

This depends on the laboratory and the equipment used. Usually, once the specimen is in the laboratory, the test takes approximately 30 minutes or less to complete.

### **Is the time of day a factor when collecting a urine sample?**

Because this is a general screening test, time is usually not important, although a first morning void is usually preferred. However, if your doctor is looking for a specific finding, he may ask that you collect a sample at a specific time. For example, if he is looking for the excretion of glucose, it's better to collect a specimen after a meal. If he is looking for low levels of protein, it's better to collect a concentrated specimen, such as a first morning specimen.

### **Are there home test kits available?**

Kits to perform a urinalysis are not available because the test requires special equipment and technical skills. However, some commercial testing strips can be purchased at a pharmacy to perform part of the chemical examination, such as urine pH, urine glucose, and urine ketones.