LESSON

5-5

Microscopic Examination of Urine Sediment

LESSON OBJECTIVES

After studying this lesson, the student will:

- **Name the preferred specimen for the microscopic examination of urine.**
- **Name four types of cells that can be found in urine sediment and give their significance.**
- **Explain how casts are formed and name three types of casts that can be present in urine.**
- **List the reference values for red and white blood cells, casts, and bacteria in urine.**
- **List six crystals that can be present in normal urine and state the pH at which each usually occurs.**
- **Describe how to prepare urine sediment for microscopic examination.**
- **List four abnormal crystals that can occur in urine sediment.**
- **Identify cells, casts, crystals, and other sediment components in urine specimens or from visual aids.**
- **Prepare a specimen for microscopic examination of urine sediment.**
- **Perform a microscopic examination of urine sediment and identify the components.**
- **Report the results of a microscopic examination of urine sediment.**
- **Describe safety precautions that must be observed when preparing urine sediment for microscopic examination.**
- **Discuss the importance of quality assessment procedures in performing the microscopic examination of urine sediment.**
- **Define the glossary terms.**

GLOSSARY

amorphous / without definite shape

cast / in urinalysis, a protein matrix formed in the kidney tubules and washed out into the urine

flagellum (pl., flagella) / slender, lashlike appendage that serves as organ of locomotion for sperm cells and some protozoa

hyaline / transparent, pale

protozoa / unicellular eukaryotic organisms, both free-living and parasitic

sediment / solids that settle to the bottom of a liquid

supernatant / the clear liquid remaining at the top of a solution after centrifugation or settling out of solid substances; the liquid lying above a sediment

yeast / a small, single-celled eukaryotic fungus that reproduces by fission or budding

INTRODUCTION

Microscopic examination of urine sediment is the third part of the routine urinalysis. In some laboratories, no microscopic examination is performed if the physical and chemical examinations are normal. However, microscopic examination can provide much helpful information. The examination can reveal infection, disease, or trauma in the urinary tract. In addition, certain findings, such as the presence of abnormal crystals, can suggest a metabolic disorder.

COMPONENTS OF URINE SEDIMENT

Urine sediment refers to the solids that settle to the bottom of the urine specimen after centrifugation or when urine is allowed to stand undisturbed. Urine sediment is obtained by centrifuging a standard volume of urine. Most of the supernatant, the liquid lying over the sediment, is then removed and the remaining sediment is resuspended and examined microscopically.

The components that can be seen in urine sediment include blood and epithelial cells, crystals, casts, amorphous material, and microorganisms. These are identified through microscopic examination of the sediment, and the numbers present are estimated and reported. Urine sediment can be observed unstained, or using stains such as Sedi-Stain and KOVA Stain, which aid in component identification.

Cells

Several types of cells can be present in urine sediment, including blood cells, epithelial cells, and microorganisms (Figure 5-20). In health, cells in urine sediment are normally few in number. An increase in a particular cell type can indicate the presence of certain pathological conditions. Cells in urine sediment are identified, quantified, and reported as a part of the microscopic examination of urine.

Blood Cells

Normal urine can contain a few blood cells. Blood cells are best identified using the high-power (40×) objective.

- Red blood cells—Red blood cells look like pale, light-refractive disks when viewed under high power (Figure 5-20A). The presence of large numbers of red blood cells in urine is called hematuria and is an abnormal condition indicating urinary system disease or trauma.
- White blood cells—A few white blood cells can be present in normal urine (Figure 5-20B). The segmented neutrophil is usually the predominant type. White blood cells are slightly larger than red blood cells, have a granular appearance, and have a visible nucleus. The numbers of white blood cells are increased in urinary tract infections.

Epithelial Cells

Epithelial cells are constantly sloughed off from the lining of the urinary tract and washed into the urine. Epithelial cells are larger than white blood cells and appear flattened, each cell having a distinct nucleus and a large amount of cytoplasm. These cells are identified and classified using the high-power (40×) objective. The most commonly seen epithelial cell is the squamous epithelial cell (Figure 5-20A,D); less commonly seen are the smaller bladder and renal tubular cells (Figure 5-20C). The presence of large numbers of renal tubular cells indicates possible chronic or acute renal disease, particularly disease affecting renal tubules.

Microorganisms

Microorganisms should not be present in normal urine. The presence of large numbers of microorganisms in recently collected

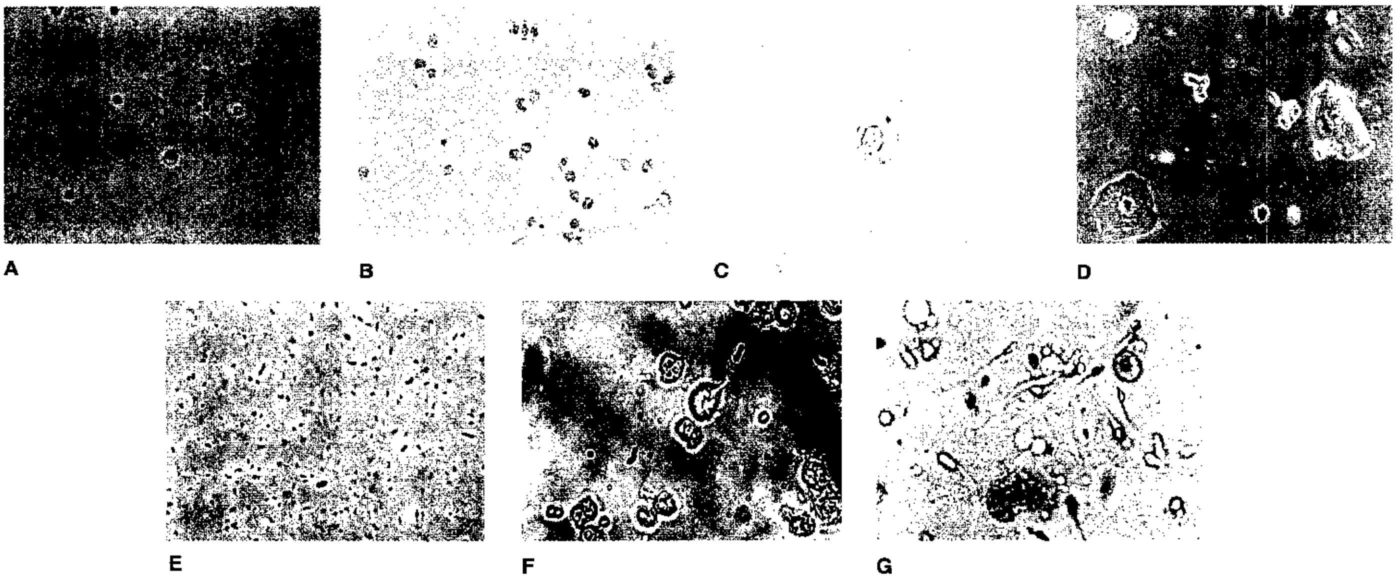


FIGURE 5-20 Cells in urine sediment: (A) squamous epithelial cells, red blood cells, and white blood cells; (B) white blood cells; (C) renal tubular cell; (D) yeasts and squamous epithelial cells; (E) bacteria; (F) *Trichomonas*; (G) spermatozoa (*Photos Courtesy of Bayer Healthcare and CDC*)

urine indicates infection. Microorganisms are observed using the high-power (40×) objective.

- Bacteria—Bacteria appear as tiny round or rod-shaped structures. Rod-shaped bacteria are usually more easily recognized than are cocci, which often resemble amorphous material (Figure 5-20E).
- Yeasts—Yeasts, single-celled fungi, can be present in urine sediment (Figure 5-20D). The most common yeast found in urine is *Candida albicans*. Yeasts are ovoid and are often seen budding or in chains. Yeast cells are smaller than red blood cells but, in low numbers, might be mistaken for red blood cells. A simple method for differentiating between yeasts and red blood cells is to add one drop of dilute acetic acid to a drop of urine sediment and then observe the sediment microscopically. The acid will not affect yeast cells; if present, they will still be visible. The acid will lyse (destroy) the red blood cells; if they were initially present, they will no longer be visible.
- Protozoa—Protozoa are free-living or parasitic single-celled eukaryotic organisms. *Trichomonas vaginalis*, a parasite of the urogenital tract, can be present in urine (Figure 5-20F). This organism moves through the action of flagella, slender, lashlike appendages. *Trichomonas vaginalis* is usually recognized during the microscopic examination by its characteristic twitching movement.

Spermatozoa

Spermatozoa are occasionally observed in urine and are easily identified by the oval head and single long flagellum (Figure 5-20G). They can be motile or nonmotile.

Casts

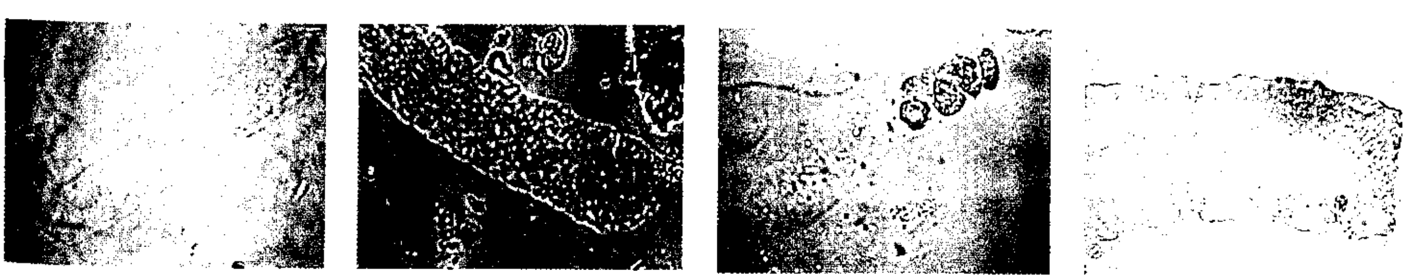
Kidney tubules normally secrete small amounts of mucoprotein. In conditions of slow urine flow, acid pH, and increased solutes, this protein accumulates and begins to gel, forming casts. The casts are molds of the tubule in which they form, hence their name. Any substances present in the tubule when the casts form, such as cells or cell remnants, become trapped in the protein. The casts dislodge and wash into the urine, where they are visible in urine sediment.

Casts are cylindrical, with rounded or flat ends, and are classified according to the substances observed in them (Figure 5-21). Casts are counted using the low-power objective (10×) and low light, and classified using the high-power (40×) objective. It is normal to see an occasional hyaline cast in urine. The presence of any other type of cast indicates possible renal disease or damage. Table 5-10 lists some conditions associated with different types of casts.

- Hyaline casts—Hyaline casts are transparent, colorless cylinders and are best seen by reducing the light on the microscope and/or lowering the condenser (Figure 5-21A).
- Granular casts—A granular cast contains remnants of disintegrated cells that appear as fine or coarse granules embedded in the protein (Figure 5-21B).
- Cellular casts—Cellular casts can contain epithelial cells or red or white blood cells embedded in the protein matrix (Figure 5-21C). White blood cell casts can be seen in kidney infections.
- Waxy casts—Waxy casts have an irregular outline (Figure 5-21) and are thought to be old casts that formed due to prolonged tubular stasis.

TABLE 5-10. Examples of conditions associated with the presence of casts in urine sediment

CAST TYPE	ASSOCIATED CONDITIONS
Hyaline	Occasional is normal; increased—stress, exercise, chronic renal disease, glomerulonephritis, pyelonephritis, congestive heart failure
Granular	Stress, exercise, pyelonephritis, glomerulonephritis
Cellular:	
Red blood cells	Strenuous exercise, glomerulonephritis
White blood cells	Pyelonephritis
Epithelial cells	Damage to renal tubules
Waxy	Chronic renal failure



A B C D

FIGURE 5-21 Casts in urine sediment: (A) hyaline; (B) granular; (C) cellular; (D) waxy cast
(Courtesy Hycor Biomedical Inc., Garden Grove, CA)

Crystals and Amorphous Deposits

A variety of crystals can be present in normal urine. Crystal formation is influenced by pH, specific gravity, and temperature. The presence of urine crystals has not been associated with increased incidence of *urolithiasis* (kidney stones). Although most urine crystals have no clinical significance, there are some rare crystals that appear in urine because of certain metabolic disorders. Therefore, it is important to be able to recognize both normal and abnormal crystals. Crystals, when seen, should be identified and reported.

Normal Crystals in Acid Urine

The normal crystals most commonly seen in acid urine are amorphous urates, calcium oxalate, and uric acid (Table 5-11).

- Amorphous urates—The urates are called amorphous because they have no specific shape. When amorphous urates are present, the centrifuged sediment may appear pink to the eye, but microscopically the sediment will appear as fine, yellowish granules.

TABLE 5-11. Crystals present in normal urine

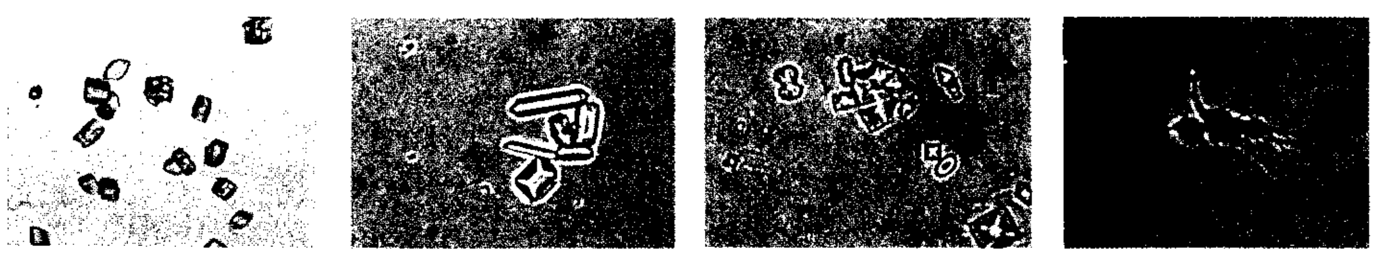
	URINE pH		
CRYSTAL	**ACID**	**NEUTRAL**	**ALKALINE**
Uric acid	+		
Amorphous urates	+		
Calcium oxalate	+	+	
Amorphous phosphates		+	+
Calcium phosphate		+	+
Triple phosphate		+	+
Ammonium biurate			+
Calcium carbonate			+

- Calcium oxalate—Calcium oxalate forms colorless, refractile, octahedral crystals. Microscopically, they look like *envelopes*, having an X intersecting the crystal, and can vary in size (Figure 5-22C). Calcium oxalate crystals are commonly seen after ingesting large doses of vitamin C or foods high in oxalate, such as tomatoes or spinach. Calcium oxalate crystals can also be seen in neutral pH urine.
- Uric acid—Uric acid can form yellow-brown crystals that have a variety of shapes: irregular, needle-like, rhombic, clusters, or rosettes (Figure 5-22A). Uric acid crystals may be seen in the urine of patients with gout.

Normal Crystals in Neutral or Alkaline Urine

Several types of crystals can occur in neutral to alkaline urine, including amorphous phosphates, calcium phosphate, and triple phosphate. Amorphous phosphates and triple phosphate can also sometimes form in urine that is only slightly acidic, pH 6.5 or higher. Calcium carbonate and ammonium biurate usually occur only in alkaline urine (Table 5-11). Crystals that form in alkaline urine are usually soluble in strong acids.

- Amorphous phosphates—Phosphates appear as white precipitate in the sediment of centrifuged urine having a neutral to alkaline pH. Microscopically they appear as colorless, amorphous, granular particles. Amorphous phosphates are soluble in 10% acetic acid.
- Triple phosphate—Ammonium magnesium phosphate crystals, commonly called triple phosphate crystals, are six-sided, colorless, highly refractile prisms (Figure 5-22B). They have a very distinctive appearance and are often described as *coffin-lids*. These can be present in neutral to alkaline urine.
- Calcium phosphate—Calcium phosphate crystals occur in neutral or alkaline urine. They are large, flat, thin plates that can appear granular and can be mistaken for squamous epithelial cells.
- Calcium carbonate—Calcium carbonate forms small, colorless, dumbbell-shaped or leaf-shaped crystals in alkaline urine.
- Ammonium biurate—Ammonium biurate crystals are also called *thorn apples* because they appear as yellow-brown spheres with thorny projections. These crystals are found in alkaline urine and will revert to uric acid crystals when treated with strong acid (Figure 5-22D).



A B C D

FIGURE 5-22 Crystals in urine sediment: (A) uric acid; (B) triple phosphate; (C) calcium oxalate; (D) ammonium biurate (*Courtesy Bayer Healthcare*)

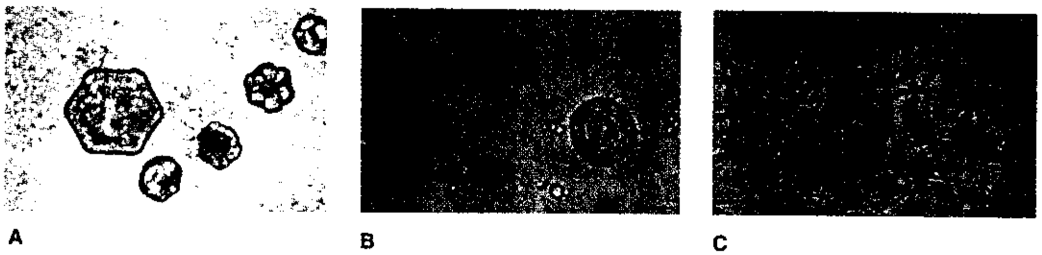


FIGURE 5-23 Abnormal crystals in urine: (A) cystine; (B) leucine; (C) tyrosine
(*Courtesy Hycor Biomedical Inc., Garden Grove CA, and Bayer Healthcare, Norwood MA*)

Abnormal Crystals in Urine

Abnormal crystals can occur in the urine of patients with certain metabolic diseases or after administration of low solubility drugs such as sulfa drugs. Some abnormal crystals are cystine, tyrosine, leucine, cholesterol, hippuric acid, and sulfa (Table 5-12 and Figure 5-23). Abnormal crystals are not frequently seen but, when present, are usually in acid urine.

- Cystine—Cystine forms colorless, refractile, flat, hexagonal crystals, often with unequal sides. Presence of these crystals in urine indicates disease such as *cystinuria*, a condition in which the amino acid cystine is not reabsorbed by the kidney (Figure 5-23A).
- Leucine—Leucine crystals are refractile, oily-appearing spheres. They can be yellow-brown in color and have concentric striations. Presence of these crystals in urine is an indication of liver disease or damage (Figure 5-23B).
- Tyrosine—Tyrosine forms fine needles arranged in sheaves. Presence of these crystals indicates liver disease or damage (Figure 5-23C).
- Cholesterol—Cholesterol crystals are colorless, flat plates with notched or broken corners.
- Sulfa—Sulfa crystals are now rarely seen because of the increased solubility of newer sulfa drugs. When seen, they appear as bundles of needles with striations.
- Hippuric acid—Hippuric acid is a byproduct of the breakdown of benzoic acid and is found in small amounts in normal urine. It is also formed when xylene and toluene are metabolized. Levels of hippuric acid can be used to monitor workplace exposure to these solvents or to monitor substance abuse, such as glue sniffing. When levels of hippuric acid rise, crystals can form in the urine. These appear as colorless, slender needles or prisms.
- Radiographic media—Occasionally crystals are present in urine for a brief period following intravenous radiographic studies or retrograde cystograms that use diatrizoate dyes. These crystals usually appear as flat, colorless plates or slender rectangles. When present, they can cause urine specific gravity to be abnormally high (greater than 1.040).

TABLE 5-12. Abnormal crystals in urine sediment

CRYSTAL	MICROSCOPIC APPEARANCE
Cholesterol	Colorless flat plates with notched or broken corners
Cystine	Colorless, hexagonal plates
Hippuric acid	Colorless to yellow needles or prism-like structures
Leucine	Yellow-brown spherical crystals showing concentric circles
Sulfa	Yellow to brown-green rosettes or bundles of needles
Tyrosine	Colorless to pale yellow sheaves of needles

Other Substances in Urine Sediment

Mucus from the urinary tract lining and contaminants such as fibers, hair, starch or talc granules, and oil droplets sometimes are present in urine sediment (Figure 5-24). These substances must be recognized and should not be confused with clinically significant substances in the sediment. Mucus, when seen, is reported; contaminants or artifacts are not.

PERFORMING THE MICROSCOPIC EXAMINATION OF URINE SEDIMENT

The procedure for microscopic examination of urine and the policy for reporting results must be standardized for each laboratory according to equipment and supplies that are available in the particular laboratory.

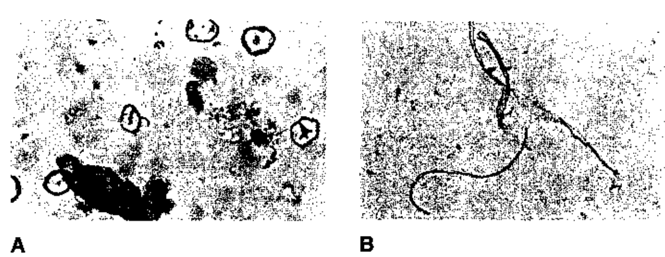


FIGURE 5-24 Other substances in urine:
(A) starch granules; (B) cotton fibers

Safety Precautions

Because urine is a biological fluid, Standard Precautions must be followed when preparing urine sediment for microscopic examination. Appropriate personal protective equipment (PPE), including gloves and face protection, must be worn during specimen handling, preparation, and evaluation. The creation of splashes or aerosols must be avoided. Safety guidelines for the use of the centrifuge must be followed (see Lessons 1-5 and 1-9). The use of microscope slides with beveled corners will decrease the likelihood of injury or glove tears when handling slides. Sediment slides must be discarded in a sharps container.

Quality Assessment

Each laboratory procedure manual will describe the procedure for microscopic examination of urine, including the volume of urine to be used for each microscopic exam, the length and force of centrifugation, the volume used to resuspend sediment, and the counting and reporting methods. These guidelines must be followed by all technicians performing the examinations in order to minimize individual differences in technique.

Because urine sediment components deteriorate rapidly, stable controls for urine microscopy are more difficult to produce than are controls for biochemical tests. However, controls such as KOVA-Trol from Hycor contain stabilized red and white blood cells. These controls can be used to check technicians' recognition of blood cells in urine specimens. Each level of control should be tested at least daily or once each shift in which the tests are performed. All control results must be recorded.

Specimen Collection and Handling

The preferred specimen is a midstream early morning specimen. The use of midstream specimens prevents contamination of the specimen with epithelial cells and microorganisms. Early morning specimens are usually more concentrated, which increases the chances of finding certain sediment components. In addition, concentrated urines protect some sediment components from deterioration. Red and white blood cells and epithelial cells can be damaged or destroyed in dilute urines, causing the numbers of these components to appear falsely decreased. All urine specimens should be examined as soon as possible after collection to prevent cellular deterioration and multiplication of any bacteria present.

Preparing the Sediment

The procedure for preparing urine sediment must be standardized within each laboratory. Typically, procedures use 10, 12, or 15 mL of well-mixed urine. The urine is poured into a conical centrifuge tube and centrifuged at 400g for 5 minutes. The supernatant is then carefully removed by pouring or pipeting. By gently tapping the tip of the tube, the sediment is resuspended in the urine remaining in the tube (0.5 to 1.0 mL). One drop of the suspension is pipetted onto a glass microscope slide and covered with a coverglass.

Several commercial systems are available that standardize the procedure for preparing and examining sediment and thus eliminate variation in technique among technicians. Urisystem by Fisher Scientific, KOVA System by Hycor Biomedical, and CenSlide 2000 by StatSpin, Inc., are examples of such systems (Figures 5-25, 5-26, and 5-27). These systems include centrifuge tubes, pipets, and plastic slides designed to ensure that a standard amount of urine is centrifuged and a standard amount of sediment is examined. Most systems also include an optional urine stain to make it easier to identify sediment components.

Counting Sediment Components

Counting and reporting methods can differ slightly among laboratories; therefore, the method used must always be that of the laboratory where the test is being performed. A microscope equipped with phase contrast optics is preferred for observing urine sediment. However, if a conventional light microscope is used, the light level can be decreased and the condenser lowered to provide more contrast and make it easier to see elements such as casts.

The sediment slide is examined using the low power objective (10×) to count elements that are few in number, such as casts. The high-power objective (40×) is used to identify and count red and white blood cells, epithelial cells, yeasts, bacteria, and crystals, and to identify casts. For each component, 10 to 15 consecutive microscopic fields are scanned and the numbers of each component present in each field are recorded.

Reporting Results

White blood cells, red blood cells, and epithelial cells are reported as the number of cells per high power field (HPF) and are usually reported as a range, such as 0–2, 2–4, 4–8, etc. (Tables 5-13 and 5-14). To determine the number to report, the total number of a component seen in all microscopic fields examined is divided by the total number of fields examined.

For example, 10 HPF fields were counted and the numbers of red blood cells seen in the 10 fields were 2, 4, 0, 1, 3, 2, 0, 1, 2,

FIGURE 5-25 Stat-Spin CenSlide standardized urinalysis system (*Photo courtesy of StatSpin Inc., Norwood, MA*)

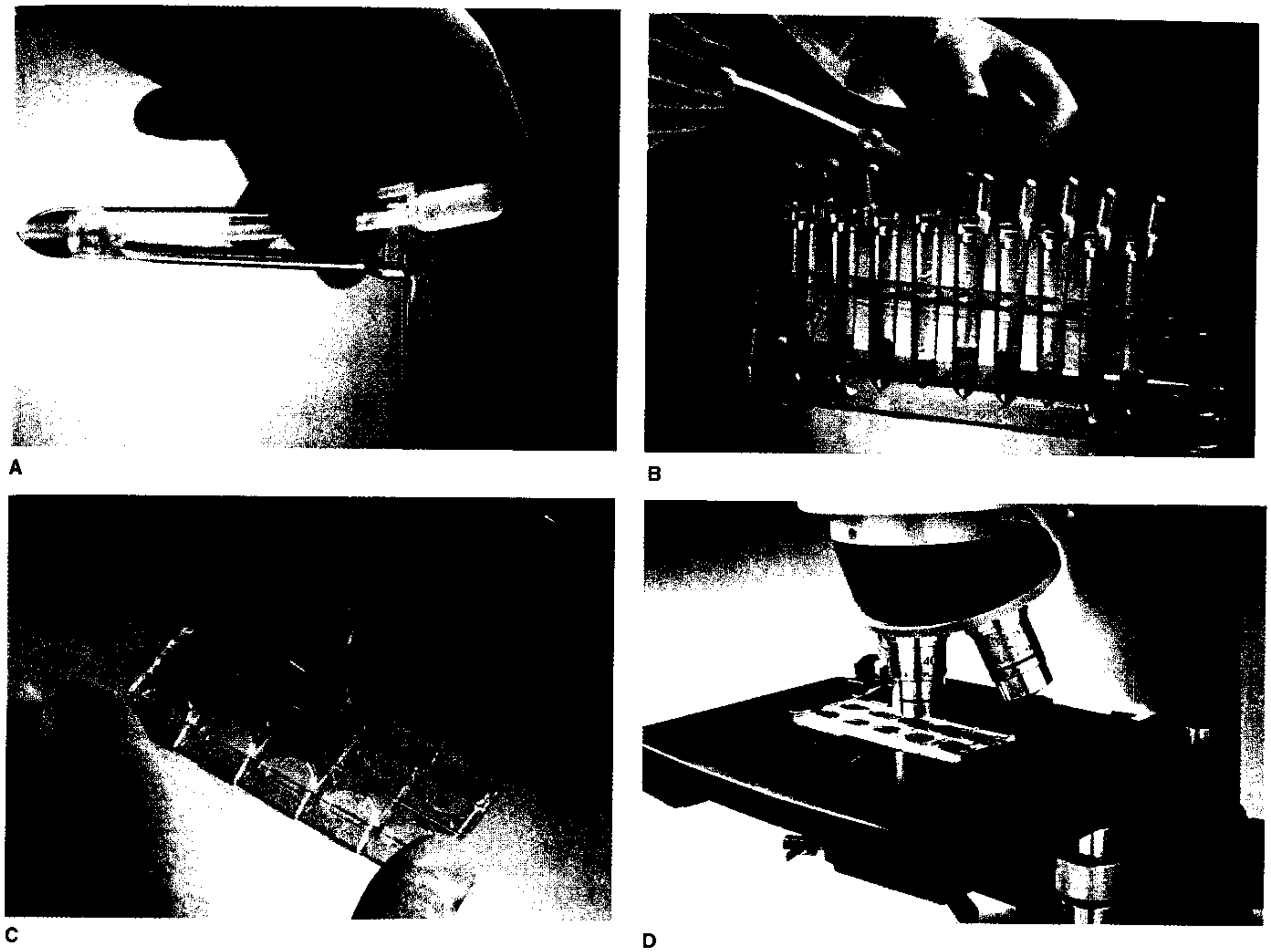


FIGURE 5-26 Using the KOVA system for standardized urinalysis: (A) pour off supernatant from centrifuged urine; (B) stain the sediment (optional); (C) load the slide chamber using the KOVA pipet; (D) observe microscopically (*Courtesy Hycor Biomedical Inc., Garden Grove, CA*)

and 4. The total number of red blood cells seen (19) should be divided by the total number of fields counted (10) to give an average of 1.9 red blood cells per HPF. Using the ranges given earlier, this would be reported as *0–2 RBCs/HPF*.

When a component is not seen in every field, it can be reported as rare (only one seen per five fields) or occasional (only one seen per one to three fields). Casts are reported as number of casts per low power field (LPF). Casts should also be identified as hyaline, granular, or cellular. Table 5-14 lists the reference values for urine sediment.

Microorganisms such as yeasts and *Trichomonas* should be reported, if seen. Bacteria are usually reported only if large numbers are seen in a recently collected urine sample that has been properly collected. Bacteria are reported as neg, 1+, 2+, 3+, or 4+.

Mucus and crystals should be reported if seen, and crystals should be identified. Mucus is usually reported as negative, 1+, 2+, 3+, and 4+. Spermatozoa are reported according to laboratory policy.

Once the microscopic examination is complete, the results of the physical and chemical examination of the specimen should

FIGURE 5-27 Using the CenSlide urinalysis system (*Courtesy of StatSpin Inc., Norwood, MA*)

TABLE 5-13. Example of a typical method of counting and identifying components of urine sediment

SEDIMENT COMPONENT	IDENTIFY USING:	COUNT USING:	REPORT:
Red blood cells	HP	HP	Average # / HPF
White blood cells	HP	HP	Average # / HPF
Epithelial cells	HP	HP	Average # / HPF
Casts	HP	LP	Average # / LPF
Bacteria/yeasts	HP	HP	0–4+*
Mucus	HP	HP	0–4+
Crystals	HP	—	Type present

0 = none seen in 10 fields
Rare = only 1 seen per 5 fields
Occasional = only 1 seen per 1–3 fields
HP = high power objective; HPF = high power field
LP = low power objective; LPF = low power field
* Usually only reported when large numbers are present in fresh urine

TABLE 5-14. Reference values for components of urine sediment

COMPONENT	REFERENCE VALUE
Red blood cells/HPF	0–4
White blood cells/HPF	0–4
Epith/HPF	Occasional (may be higher in females)
Casts/LPF	Occasional, hyaline
Bacteria	Negative
Yeasts	Negative
Mucus	Negative to 2+
Crystals	Types present vary with pH (crystals such as cystine, leucine, tyrosine, and cholesterol are considered abnormal)

HPF = high power field
LPF = low power field

TABLE 5-15. Correlation of microscopic examination of urine sediment with physical and chemical urinalysis results

MICROSCOPIC FINDINGS	EXPECTED RESULTS	
	PHYSICAL	CHEMICAL
White blood cells*	Turbid	+ protein + nitrite* + leukocytes*
Red blood cells**	Turbid, red color	+ blood
Large numbers of epithelial cells	Turbid	—
Casts	Clear to turbid	+ protein
Normal crystals	Turbid	pH acid to alkaline
Bacteria	Turbid	+ nitrite

*In cases of bacterial infection, may also see bacteria
**Red blood cells may not be seen if hemolysis has occurred

be reviewed to confirm that the microscopic examination results agree or correlate with the physical and chemical tests (Table 5-15). For instance, if the chemical strip test was positive for leukocyte esterase, it would be expected that increased numbers of white blood cells would be seen in the microscopic examination.

Urine Analyzers

Several semi-automated analyzers are available for urinalysis. These instruments have the advantages of processing large numbers of samples rapidly, improving standardization, and decreasing clerical errors. One fully automated analyzer is the IRIS iQ200 Urinalysis System manufactured by International Remote Imaging Systems, Inc. The iQ200 performs the physical, chemical, and microscopic parts of routine urinalysis by linking together modules that perform each part of the examination.

The technologist loads a well-mixed, bar-coded aliquot of urine into a sample tray on the analyzer. Physical and chemical examinations are performed first. The instrument mixes the sample again and robotically dispenses urine onto pads of a reagent strip. The reactions are read colorimetrically at the appropriate times. Urine color is determined spectrophotometrically, transparency is determined using a turbidimeter, and specific gravity is read using an internal refractometer. The specimen is then moved to the microscopy analyzer. There the sample passes through a flow cell where 500 digital images are taken of each sample. Using particle recognition software, 12 urine sediment components can be identified and categorized into 14 categories based on characteristics such as size, shape, texture, and contrast. The categories are red blood cell, white blood cell, white blood cell clump, hyaline cast, unclassified cast, crystals, squamous epithelial cell, nonsquamous epithelial cell, yeast, bacteria, mucus, sperm, amorphous, and unclassified. Before results are reported, abnormal results are visually confirmed by a technologist using a video screen. Images are archived and can be viewed at any time; the images also can be used for teaching.

The UF-50 and UF-100i by Sysmex use laser flow cytometry to differentiate among, and determine numbers of, formed elements in urine sediment (Figure 5-28). This urine sediment analyzer operates similarly to hematology flow cytometry analyzers, which are discussed in Lesson 2-13. As stained sediment components flow through the analyzer, measurements are made of fluorescence, scatter, and impedance, providing identification and classification of 10 components. A specimen having unusual results is flagged, and the results are confirmed microscopically by the technician.

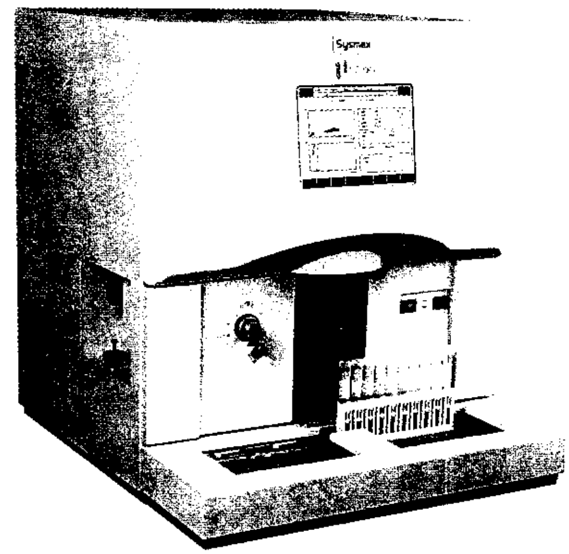


FIGURE 5-28 Sysmex UF 100i fully automated urine analyzer (*Courtesy Sysmex America, Inc., all rights reserved*)

TABLE 5-16. Correlation of urine sediment components with a physiologic condition such as strenuous exercise and some disease states

	CONDITION/DISEASE			
COMPONENT	**STRENUOUS EXERCISE**	**ACUTE CYSTITIS**	**GLOMERULONEPHRITIS**	**CHRONIC END STAGE KIDNEY DISEASE**
White blood cells	0–1×	4×	2×	1–2×
Red blood cells	0–1×	2×	4×	1–2×
Bacteria	0	+	0	±
Renal epithelial cells	0	0	1×	1–2×
Hyaline casts	3–4×	1×	1–2×	2×
Granular casts	1×	0	1–2×	1–2×
White blood cell casts	0	0	1–2×	1–2×
Red blood cell casts	0	0	4×	1–2×

X denotes a fold increase over reference range. For example, in glomerulonephritis, a two-fold increase (2×) over the normal amount of white blood cells may be seen.
0 = count of cells or casts does not exceed reference range
± = small amount present
+ = present
1× = one-fold increase over normal
2× = two-fold increase over normal
3× = three-fold increase over normal
4× = four-fold increase over normal

SAFETY Reminders

Review safety section before beginning procedure.

Use Standard Precautions when handling urine specimens.

Wipe the work area promptly with surface disinfectant if spills occur and when work is finished.

Use proper safety procedures when operating the centrifuge.

Avoid creating splashes or aerosols when pouring urine from the centrifuge tube and discarding specimen.

Discard slides in a biohazard sharps container.

PROCEDURAL Reminders

Review quality assessment section before beginning procedure.

Follow standard operating procedure in preparing urine sediment.

Adjust the microscope light, iris diaphragm, and condenser of the microscope to give the best contrast of urine sediment.

Use the fine adjustment to continually focus up and down to facilitate finding components, especially casts.

Differentiate yeasts from red blood cells by performing the acetic acid test.

CASE STUDY

A complete urinalysis was performed on a fresh, random specimen. The results are given below.

Physical Test	Patient Results
clarity	slightly turbid
color	yellow
SG	1.015

Chemical Test	Patient Results
pH	6.4
protein	1+
glucose	neg
ketone	neg
bilirubin	neg
blood	neg
urobilinogen	neg
nitrite	neg
leuk. esterase	1+

Microscopic Exam	Patient Results
WBC	6–8/HPF
RBC	10–15/HPF
epith cells	0–2/HPF
casts	rare/HPF
bacteria	neg
yeasts	neg
crystals	none seen

1. Which chemical and microscopic results show a discrepancy?
   a. + leukocyte esterase and 6–8 white blood cells/HPF
   b. negative blood and 10–15 red blood cells/HPF
   c. 1+ protein and 6–8 white blood cells/HPF
   d. neg nitrite and 6–8 white blood cells/HPF
2. What follow-up test(s) would be appropriate to resolve the discrepancy?

SUMMARY

Examination of urine sediment is an important part of the routine urinalysis and is considered by many to be the single most important test in the diagnosis of renal disease (Table 5-16). Experience is required to become proficient in the microscopic identification of urine sediment components. Because there are few controls for urine sediment, it is very important that each laboratory standardize the technique of sediment preparation and counting and reporting procedures. Standardizing these procedures is made easier by the use of commercial urinalysis systems such as UriSystem and KOVA System as well as semi-automated and fully automated urine analyzers.

Reproducibility of results is important when tests are performed by different technicians. For example, patients with acute or chronic kidney disease may have urinalysis performed frequently to monitor the course of the disease and/or the effectiveness of treatment. When standardized procedures are followed with every patient sample, clinicians can be assured that changes in urinalysis results are not due to technical variation but are reliable indicators of the patient's condition.

REVIEW QUESTIONS

1. What is the preferred urine specimen for microscopic examination of urine sediment?
2. How is urine sediment prepared for a microscopic examination?
3. Why are microscopic urine tests important?
4. Why is it important to wear gloves and avoid splashes when handling urines?
5. What happens to cells in dilute urine samples?
6. What is the advantage of a standardized urine system such as the KOVA System or UriSystem?
7. Name four types of cells that can be seen in urine sediment.
8. Explain how casts are formed.
9. Name eight crystals that can be seen in normal urine sediment.
10. List the normal values for red blood cells, white blood cells, casts, and bacteria in urine sediment.
11. The following numbers of white blood cells were observed in 15 consecutive HPFs when performing microscopic examination of urine sediment: 6, 5, 6, 2, 7, 1, 3, 4, 8, 6, 9, 7, 6, 5, and 8. How should the white blood cells be reported for this specimen?
12. Define amorphous, cast, flagellum, hyaline, protozoa, sediment, supernatant, and yeast.

STUDENT ACTIVITIES

1. Complete the written examination for this lesson.
2. Practice identifying components of urine sediment using visuals provided by the instructor.
3. Practice performing a microscopic examination on one or more urine specimens as outlined in the Student Performance Guide, using the worksheet or report form.
4. Compare the results of the examinations with results obtained by fellow students or the instructor.
5. Compare the microscopic results with the chemical test results. Do they correlate?
6. Draw three components that were found in the urine sediments. Are they normal components of urine?

WEB ACTIVITIES

1. Use the Internet to search for information on glomerulonephritis, nephritis, and cystitis. Discuss the urine sediment components you might expect to see in each condition.
2. Use the Internet to find images of urine sediment components. Make your own reference atlas of sediment components from online images. (Be sure that you do not violate any copyrights. Most Web sites allow personal use of images.)