



GENERAL URINE EXAMINATION (URINE ANALYSIS)

Physiology Lab-8

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Background

Urine (from Latin Urina,) is a typically sterile liquid by-product of the body secreted by the kidneys through a process called urination and excreted through the urethra.

Urinalysis

A **urinalysis (UA)**, also known as **routine and microscopy (R&M)**, is an array of tests performed on [urine](#).

A part of a urinalysis can be performed by using [urine test strips](#), in which the test results can be read as color changes. Another method is [light microscopy](#) of urine samples.

Macroscopic Urinalysis

- The first part of a urinalysis is direct **visual observation**.
- Normal, fresh urine is pale to dark yellow or amber in color and clear.
- Normal urine volume is 750 to 2000 ml/24hr.
- Turbidity or cloudiness may be caused by excessive cellular material or protein in the urine.
- A red or red-brown (abnormal) color could be from a food dye, a drug, or the presence of hemoglobin.
- If the sample contained many red blood cells, it would be cloudy as well as red.

Urine Dipstick Chemical Analysis

1- pH

Urinary pH may range from as low as 4.5 to as high as 8.0.

Urine pH generally reflects the blood pH but in renal tubular acidosis (RTA) this is not the case.

2- Specific Gravity (sp gr)

- Specific gravity (which is directly proportional to urine osmolality which measures solute concentration) measures urine density, or the ability of the kidney to concentrate or dilute the urine over that of plasma.
- Specific gravity between **1.002 and 1.035** on **a random sample** should be considered normal if kidney function is normal.
- Any measurement below this range indicates **hydration** and any measurement above it indicates relative **dehydration**



3- Protein

Dipstick screening for protein is done on whole urine.

A small amount of filtered plasma proteins and protein secreted by the nephron(**mucoprotein**) (Tamm-Horsfall protein) can be found in normal urine.

Normal total protein excretion **does not usually exceed 150 mg/24 hours (or 10 mg/100 ml in any single specimen).**

More than 150 mg/day is defined as proteinuria. Proteinuria > 3.5 gm/24 hours is severe and known as **nephrotic syndrome.**

4- Glucose

Nearly all glucose filtered by the glomeruli is reabsorbed in the proximal tubules and only undetectable amounts appear in urine in healthy patients.

Above renal threshold (10 mmol/L) glucose will appear in urine.

Glycosuria (excess sugar in urine) generally means **diabetes mellitus (DM)**.

5- Ketones

Ketones (acetone, acetoacetic acid, beta-hydroxybutyric acid) resulting from either diabetic ketoacidosis or some other form of caloric deprivation (starvation), are easily detected using either dipsticks or test tablets containing sodium nitroprusside.

6- Nitrite

This test relies on the breakdown of urinary nitrates to nitrites, which are not found in normal urine. Many Gram-negative and some Gram-positive **bacteria** are capable of producing this reaction and a positive test suggests their presence in significant numbers (ie more than 10,000 per ml). A negative result does **not rule out** a UTI.

Microscopic Urinalysis

Methodology

- A sample of well-mixed urine (usually 10-15 ml) is centrifuged in a test tube at relatively low speed (about 2-3,000 rpm) for 5-10 minutes until a moderately cohesive button is produced at the bottom of the tube.
- The supernatant is decanted and a volume of 0.2 to 0.5 ml is left inside the tube. The sediment is re_ suspended in the remaining supernatant by flicking the bottom of the tube several times. A drop of resuspended sediment is poured onto a glass slide and cover slipped

Examination

The sediment is first examined under low power to identify most **crystals, casts, squamous cells**, and other large objects. The numbers of casts seen are usually reported as number of each type found per **low power field (LPF)**. Example: 5-10 hyaline casts/LPF.

Next, examination is carried out at high power to identify **crystals, cells, and bacteria**. The various types of cells are usually described as the number of each type found per average **high power field (HPF)**. Example: 1-5 WBC/HPF.

1- Red Blood Cells

Hematuria is the presence of abnormal numbers of red cells in urine due to:

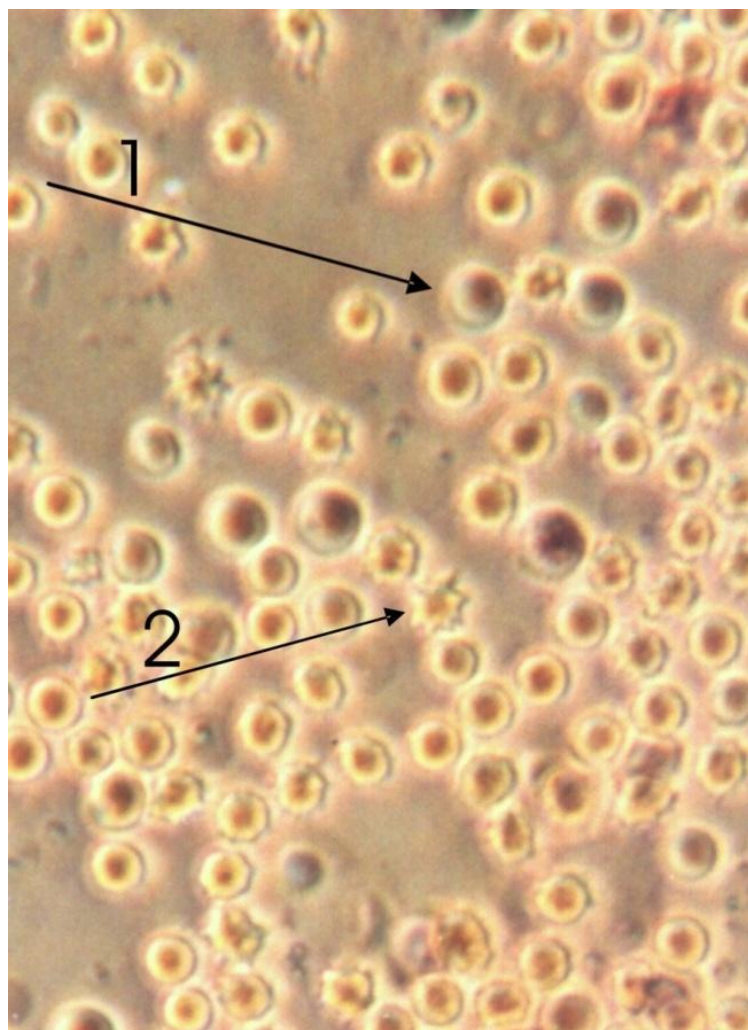
- glomerular damage.
- kidney trauma.
- urinary tract stones.
- upper and lower urinary tract infections.
- nephrotoxins.
- physical stress.
- Red cells may also contaminate the urine from the vagina in menstruating women.

Theoretically, no red cells should be found, but some find their way into the urine even in very healthy individuals.

RBC's may appear normally shaped, swollen by dilute urine (in fact, only cell ghosts and free hemoglobin may remain). Both swollen, partly hemolyzed RBC's and are sometimes difficult to distinguish from WBC's in the urine.

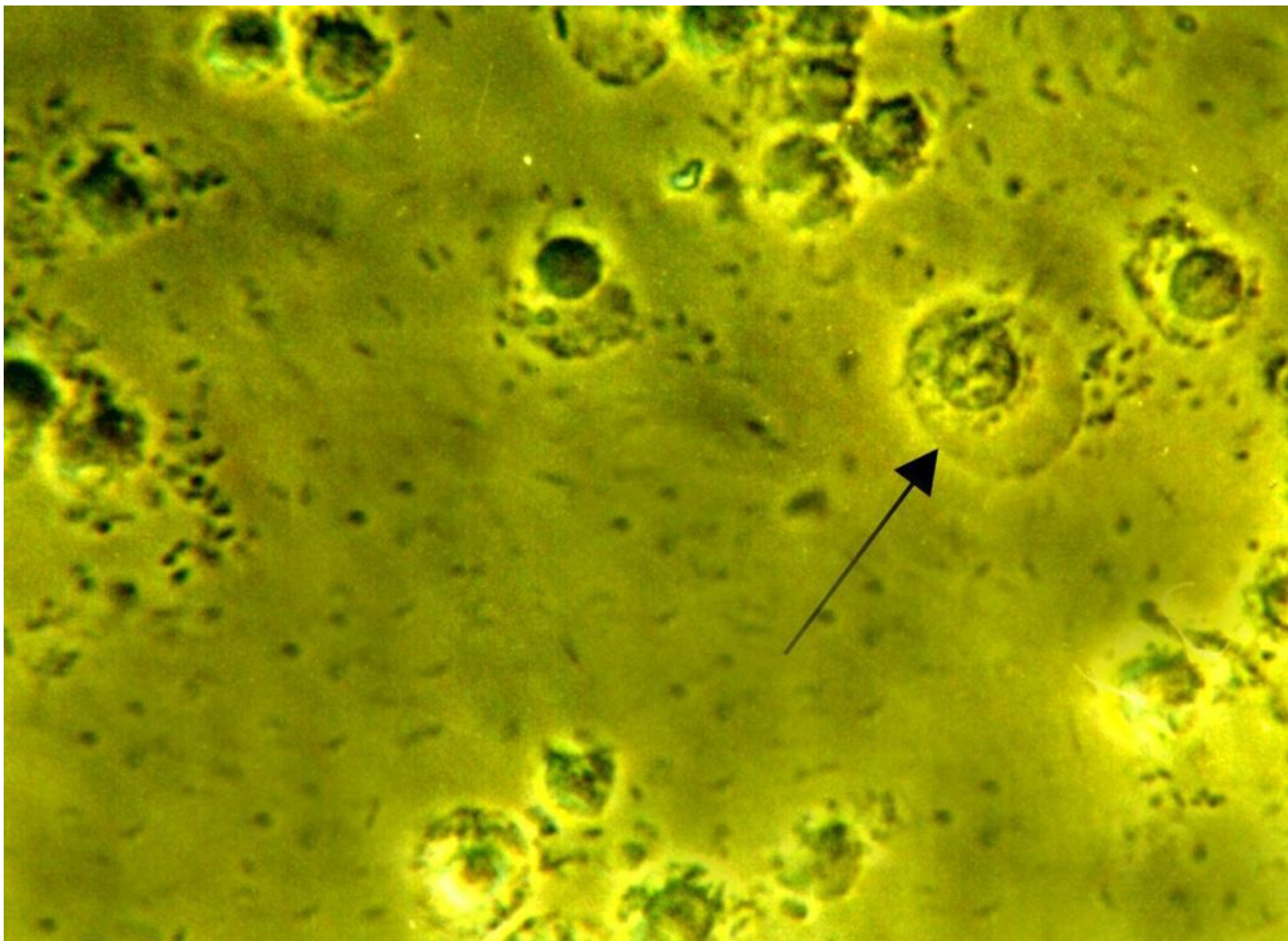
The presence of **dysmorphic RBC's** in urine suggests a **glomerular disease such as a glomerulonephritis**.

Dysmorphic RBC's have odd shapes as a consequence of being distorted via passage through the abnormal glomerular structure



2- White Blood Cells

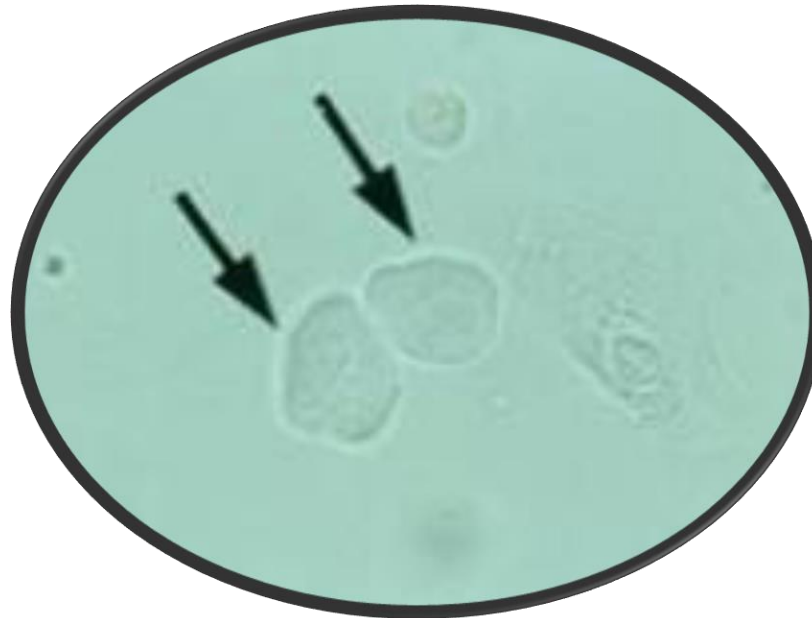
- Pyuria refers to the presence of abnormal numbers of leukocytes that may appear with infection in either the upper or lower urinary tract or with acute glomerulonephritis.
- Usually, the WBC's are granulocytes. White cells from the vagina, especially in the presence of vaginal and cervical infections.
- If two or more leukocytes per each high power field appear in non-contaminated urine, the specimen is probably abnormal.
- Leukocytes have lobed nuclei and granular cytoplasm.



3- Epithelial Cells

Renal tubular epithelial cells, usually larger than granulocytes, contain a large round or oval nucleus and normally slough into the urine in small numbers.

However, with **nephrotic syndrome** and in conditions leading to **tubular degeneration**, the number sloughed is increased.



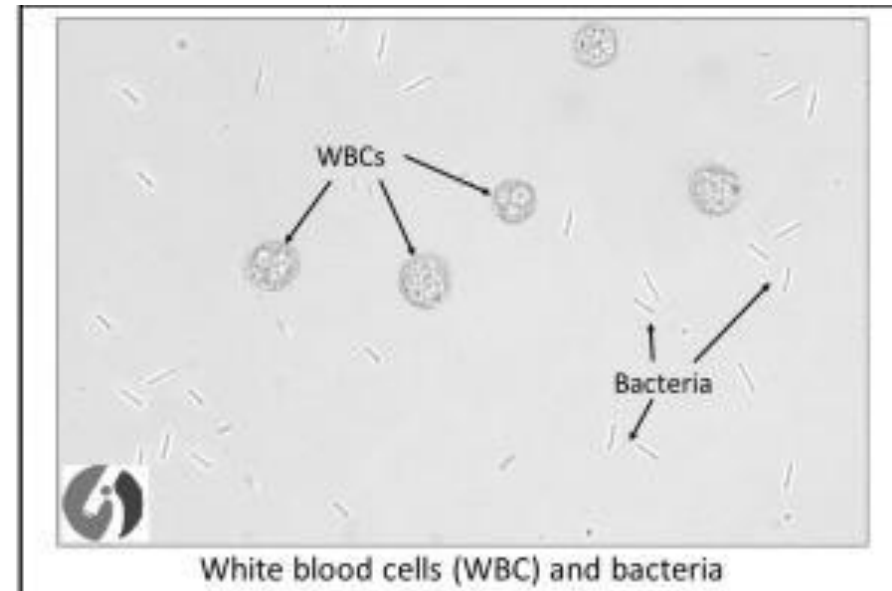
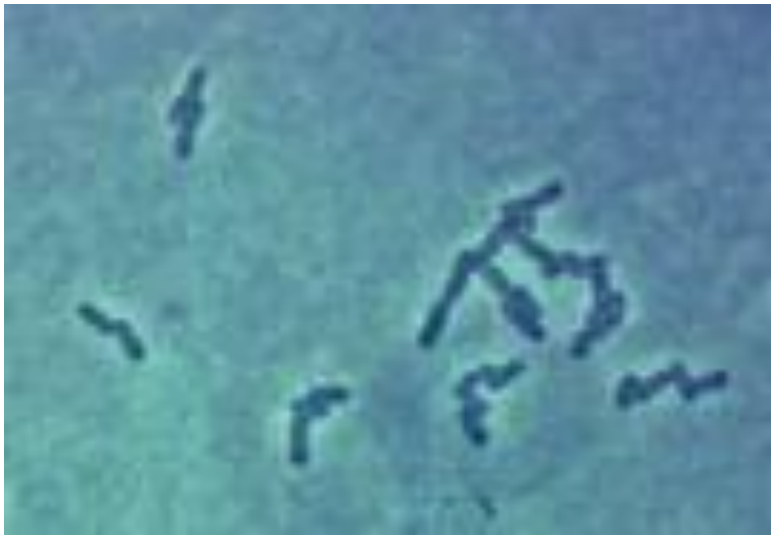
4- Casts

- They are solid and cylindrical structures formed by precipitation of debris in the renal tubules.
- Urinary casts are formed only in the distal convoluted tubule (DCT) or the collecting duct (distal nephron). The proximal convoluted tubule (PCT) and loop of Henle are not locations for cast formation.
- **Hyaline casts** are composed primarily of a mucoprotein secreted by tubule cells, hyaline cast **are seen in healthy individuals**.
- **RBCs casts** are formed when RBCs stick together and in glomerular disease.
- **WBCs casts** are seen in acute pyelonephritis and glomerulonephritis.
- Granular and waxy casts are seen in nephrotic syndrome.



5- Bacteria

- Bacteria are common in urine specimens because of the abundant normal microbial flora of the vagina or external urethral and because of their ability to rapidly multiply in urine standing at room temperature.
- Therefore, microbial organisms found in all but the most carefully collected urines should be interpreted in view of clinical symptoms.



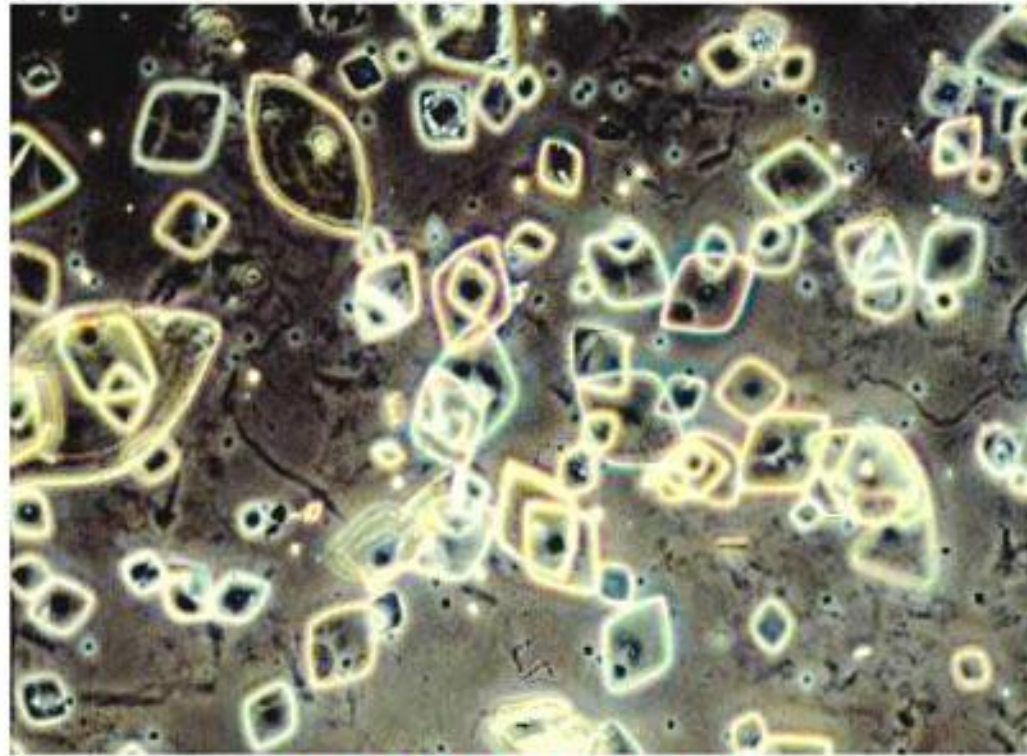
6- Yeast

Yeast cells may be contaminants or represent a true yeast infection. They are often difficult to distinguish from red cells and amorphous crystals but are distinguished by their tendency to bud. Most often they are *Candida*, which may colonize bladder, urethra, or vagina .



7- Crystals

Common crystals seen even in healthy patients include calcium oxalate, triple phosphate crystals and amorphous phosphates.

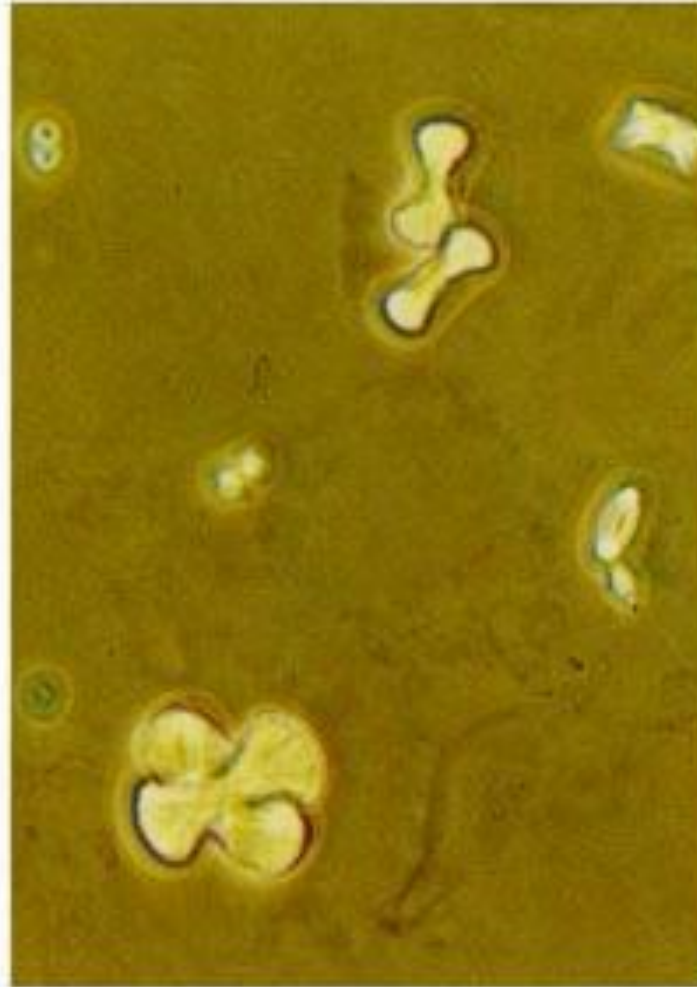


URIC ACID (U-pH \leq 5.4)

(calcium oxalate (octahydrate))



(calcium oxalate(monohydrate



**CALCIUM OXALATE
MONOHYDRATED (U-pH <5.4-6.7)**

(Ammonium magnesium (triple phosphate))

