#11 Urinary System

Objectives:

- Understand specific gravity and identify normal specific gravity values for urine
- Learn to use a urine hydrometer to measure specific gravity
- Define specific gravity and identify normal specific gravity values
- Learn to use Urispec strips and analyze results
- Identify various urine sediments observed from micrographs & posters
- Observe slide of kidney and identify specific structures
- Determine possible diseases / dietary causes / drugs for unknown urine samples using descriptive tables
- Identify structures on male and female pelvis models

Equipment: Remember to bring gloves and goggles.

I. Urinalysis Techniques

Introduction

A routine urinalysis consists of diagnostic tests used to assess urine composition. There are three categories of tests that can be performed on a urine sample: direct observation, chemical analysis, and microscopic examination of urine sediments.

Terms to know:
- turbidity — visual quality based on clarity of solution. A cloudy (turbid) appearance indicates abnormal urine contents such as protein, salts, cells and cellular contents
- specific gravity — density of a fluid as compared to distilled water; can be used as an indicator for osmolarity of the fluid. Note that specific gravity is a comparative number and therefore has no unit associated with it
- urine sediments — microscopic solids that collects at the bottom of a centrifuged urine sample; includes normal and abnormal urine components

Table 1. Normal Urine Characteristics

<table>
<thead>
<tr>
<th>Color</th>
<th>Light yellow to dark golden yellow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbidity</td>
<td>Clear</td>
</tr>
<tr>
<td>pH range</td>
<td>4.5 - 8</td>
</tr>
<tr>
<td>Specific gravity</td>
<td>1.010 - 1.025</td>
</tr>
<tr>
<td>Sediments</td>
<td>Epithelial cells, hyaline casts, crystals, mucous threads, bacteria</td>
</tr>
<tr>
<td>Solutes (~5%)</td>
<td>Electrolytes, urea, uric acid, creatinine, hormones Very small amounts of protein, glucose, bilirubin, ketones</td>
</tr>
</tbody>
</table>
Table 2. Abnormal Urine Color and Possible Causes

<table>
<thead>
<tr>
<th>Urine Color</th>
<th>Diet</th>
<th>Drugs</th>
<th>Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear to light yellow</td>
<td>Alcohol</td>
<td>Phosphate, carbonate</td>
<td>Uncontrolled diabetes mellitus</td>
</tr>
<tr>
<td>Yellow orange to dark green</td>
<td>Carrots</td>
<td>Antibiotics</td>
<td>Bilirubin from obstructive jaundice</td>
</tr>
<tr>
<td>Red to red brown</td>
<td>Beets</td>
<td>Laxatives</td>
<td>Hemoglobin and urine</td>
</tr>
<tr>
<td>Smoky red</td>
<td>Beets</td>
<td>Anticonvulsants</td>
<td>Unhemolyzed red blood cells from urinary tract</td>
</tr>
<tr>
<td>Dark wine</td>
<td>Beets</td>
<td>Anti-inflammatory drugs</td>
<td>Hemolytic jaundice</td>
</tr>
<tr>
<td>Brown black</td>
<td>Rhubarb</td>
<td>Antidepressants</td>
<td>Melanin pigment from melanoma</td>
</tr>
<tr>
<td>Brown</td>
<td>Rhubarb</td>
<td>Barbituates</td>
<td>Anemia or liver infections</td>
</tr>
<tr>
<td>Green</td>
<td>Green food dye</td>
<td>Diuretics</td>
<td>Bacterial infection</td>
</tr>
</tbody>
</table>

Table 3. Abnormal Urinalysis Results and Possible Causes

<table>
<thead>
<tr>
<th>Urinalysis Test Results</th>
<th>Possible Dietary Cause</th>
<th>Possible Disease Cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low pH ( &lt; 4.5)</td>
<td>High protein diet, cranberry juice</td>
<td>Uncontrolled diabetes mellitus</td>
</tr>
<tr>
<td>High pH ( &gt; 8.0)</td>
<td>Diet rich in vegetables, dairy products</td>
<td>Severe anemia</td>
</tr>
<tr>
<td>Low specific gravity ( &lt; 1.010)</td>
<td>Increased fluid intake</td>
<td>Severe renal damage</td>
</tr>
<tr>
<td>High specific gravity ( &gt; 1.025)</td>
<td>Decreased fluid intake, loss of fluids</td>
<td>Uncontrolled diabetes mellitus, severe anemia</td>
</tr>
<tr>
<td>Glucose present</td>
<td>Large meal consumed</td>
<td>Uncontrolled diabetes mellitus</td>
</tr>
<tr>
<td>Protein present</td>
<td>High protein diet</td>
<td>Severe anemia</td>
</tr>
</tbody>
</table>

II. Observation and chemical analysis

Materials
- Control urine samples
  - Normal
  - High glucose
  - High protein
- Unknown urine samples
  - A
  - B
- Test tubes
- Urispec 11-way strips
- Graduated cylinder (10 ml)
- Wax pencil
Methods

1. Place 10 ml of the normal urine sample into a test tube.
2. Observe the color and turbidity of the normal urine sample. Record your observations in Table 4.
3. Obtain a Urispec test strip. Completely immerse the test strip in the urine for approximately one second.
4. Remove the strip and draw it across the rim of the test tube to remove excess urine, then place it on a paper towel. Be sure to hold the strip in a horizontal position to prevent mixing of chemicals from one area of the strip to another.
5. After 30 seconds, compare the test strip with the color scale on the Urispec bottle. (Note: color changes that take place after 2 minutes are of no significance.) Record your results for the following in Table 4.
   a. pH
   b. glucose
   c. protein
   d. ketones
   e. bilirubin
6. Repeat steps 1–5 for the high glucose and high protein urine samples as well as Unknown A and Unknown B urine samples. Record your results in Table 4.

III. Specific gravity determination

Materials
- Urine hydrometer and jar (Figure 1)
- Approximately 35-50 ml of each of the following (in labeled beaker). The volume depends on the size of your jar, ask instructor
  o Normal urine sample
  o Low urine sample
  o High urine sample
- Graduated cylinder (50 ml)
- 3-50 ml beakers, labeled

Methods

1. The hydrometer is calibrated to give a reading of 1.000 for distilled water. Because the hydrometer is sensitive to temperature, the accuracy of the instrument must be checked prior to use. To check the accuracy, fill the jar 35 ml of distilled water, place the hydrometer in the jar so that it is not touching the sides and spin it lightly. When the hydrometer comes to rest, read the level of water at the meniscus on the hydrometer scale (see Figure 2). The smallest markings on the hydrometer are in 0.001 or 0.002 increments depending on the hydrometer.
Distilled water reading: __________ (to third place after decimal). **Record this in Table 5.** If the measurement is not exactly 1.000, each sample measurement must be corrected for this difference. This is called a **correction factor**; calculate using this equation:

\[
1.000 - \text{your reading} = \text{correction factor}
\]

**Record the correction factor in Table 5.** [Write if the correction factor is positive (+) or negative (-)]

2. Next, measure the specific gravity of the normal urine sample. Remove the hydrometer from the jar and pour out the water. Add 35 ml of the normal urine sample to the jar. Repeat the method in step 1 to obtain the specific gravity measurement. Record your results in Table 2. Remove the hydrometer and **POUR THE NORMAL URINE SAMPLE BACK INTO ITS ORIGINAL CONTAINER.** Rinse the hydrometer and jar well.

3. Repeat the procedure described in step 2 to obtain the specific gravity of the “HIGH” and “LOW” urine samples. Use the same correction factor previously obtained in step 1. Record your results in Table 5.

### IV. Observation of Urine Sediments

Urine sediments fall into the four general categories:

a. **cells** – epithelial cells (renal tubule cells, transitional cells, squamous cells), leukocytes, erythrocytes.
Normal urine contains small numbers of body cells. High numbers of renal tubule cells indicate kidney disease, high numbers of leukocytes indicate infection, high numbers of erythrocytes may be due to menstruation, glomerular damage, or trauma to the urinary tract.

b. **casts** – cylindrical masses of cells or other substances that collect in the distal convoluted tubule or the collecting ducts and are eventually flushed out by the flow of urine. Normal urine contains hyaline casts. RBC casts indicate glomerular damage, WBC casts indicate infection, waxy casts are the result of WBC casts that are retained in the tubules.

c. **crystals** – high concentrations of some solutes can cause the formation of crystals.
Normal urine contains crystals of uric acid, calcium oxalate, triple phosphate crystals and calcium carbonate. Abnormal urine crystals include cysteine, tyrosine, and leucine.

d. **mucus threads** – long, thin strands of mucus.
Normal urine contains small quantities of mucus threads. Large quantities indicate infection, especially sexually transmitted infections.

Methods

1. Observe the set of micrographs of urine sediments.
2. Use the chart accompanying the micrographs and posters in the lab to help identify the category of each sediment example. Record your identification in Table 6 in the lab report.
3. Draw at least one example of each type of sediment (cell, cast, crystal, and mucous thread) in the boxes in the lab report.

V. Observation of Kidney Slide

Obtain kidney cross-section slide, draw and label these structures in your lab report:

- glomerulus
- glomerular (Bowman’s) capsule
- renal tubule with simple cuboidal epithelium

The walls of the renal tubules are largely composed of simple cuboidal epithelium. The glomerular (Bowman’s) capsule and the glomerulus will be found in the outer cortex and together form a renal corpuscle (clear ring surrounding a darker staining cluster).

Have your microscope checked by your instructor (page 8) Figure 4. Kidney cross-section.

VI. Observation of Human Pelvis Models

Identify the following structures on the male and female models provided:

A. Male
1. epididymis
2. penis
3. prostate gland
4. scrotum
5. seminal vesicles
6. testis
7. urethra
8. urinary bladder
9. vas deferens

B. Female
1. cervix
2. ovary
3. urethra
4. urinary bladder
5. uterine tube
6. uterus
7. vagina
II. Table 4. Results of Observation and Chemical Analysis

<table>
<thead>
<tr>
<th></th>
<th>Normal Urine</th>
<th>High glucose Urine</th>
<th>High protein Urine</th>
<th>Unknown A Sample</th>
<th>Unknown B Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turbidity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glucose</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protein</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ketones</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bilirubin</td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

Use Tables 2. and 3. along with your test results from Table 4. to determine a probable disease diagnosis for each of the two unknown urine samples.

Unknown A diagnosis __________________     Unknown B diagnosis ________________

II. Table 5. Results of Specific Gravity Measurements

<table>
<thead>
<tr>
<th>Measured Specific gravity of water:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Correction factor:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Measured (base) Specific Gravity</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted Specific Gravity</td>
<td></td>
</tr>
</tbody>
</table>

Use Tables 2. and 3. along with your test results from Table 5. to determine a probable dietary cause for each of the low and high urine specific gravity samples.

Urine Low dietary cause_________________     Urine High dietary cause______________
IV. Urine Sediments: Categorize the urine sediment photographs (write the sediment Letter(s) next to the correct category)

<table>
<thead>
<tr>
<th>Cells</th>
<th>Crystals</th>
<th>Casts</th>
<th>Mucus threads</th>
</tr>
</thead>
</table>

Observation of Urine Sediments—Draw an example of each sediment type.

V. Kidney Slide

Objective: 40x (high power)

Labels:

Microscope Check: ____________

Last updated 08/2019
VI. Observation of Human Pelvis Models—For each label on the diagrams below, give the name of the structure on the correct line using the list from the Pelvis Models.

A. ______________________________

B. ______________________________

C. ______________________________

D. ______________________________

E. ______________________________

F. ______________________________

G. ______________________________

H. ______________________________

I. ______________________________

J. ______________________________

K. ______________________________

L. ______________________________

M. ______________________________

N. ______________________________

Female pelvis: K. Klitz, Stretch School of Medicine, Loyola University
Male pelvis: Dr. Murray Jensen, University of Minnesota

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