

# Urinary System

**Course**

Anatomy and Physiology

**Unit XV**

Urinary System

**Essential Question**

How does our Urinary System work?

**TEKS**

130.206 (c)  
1A,1B  
2A,2F,2H  
3A,3B,3E  
6A,6B  
8A,8B,8C  
10A,10B,10C,  
10D

**Prior Student Learning**

none

**Estimated time**

3-4 Hours

**\*Teacher Note**

You may choose to do one or all activities listed depending on length of your class.

**Rationale**

To pursue a career in health care, proficiency in anatomy and physiology is vital.

**Objectives**

Upon completion of this lesson, the student will be able to:

- Describe biological and chemical processes that maintain homeostasis
- List the parts of the urinary system and the functions of each
- Discuss the general functions of the urinary system
- Discuss four steps in the formation of urine
- Analyze diseases and disorders of the urinary system
- Discuss dialysis and transplants
- Label the diagram of the urinary system

**Engage**

Ask students how many times a day do they urinate? How many times do you think is normal?

Or

Discuss the following:

Homeostasis of water and electrolytes in body fluids relies on proper functioning of the urinary system. Why do you think any disease or disorder that reduces the effectiveness of the kidneys would be life threatening?

**Key Points**

- I. Introduction
  - A. Organs
    1. Kidneys
    2. Ureters
    3. Urinary bladder
    4. Urethra
  - B. Function: maintain homeostasis of body fluids through excretion of wastes and solutes and selective reabsorption of certain electrolytes and other components
- II. Kidneys
  - A. Function: control the volume, composition, and pressure of body fluids by regulating excretion of wastes and solutes; filter blood and maintain balance of pH in the blood
  - B. Anatomy: 2 bean shaped organs, 4-6 ounces each, located retroperitoneal, just above the waist, 4 inches long by 2-3 inches wide by 1 inch thick; left is slightly larger and higher,

protected by large fat pads encapsulated with renal fasciae

1. Hilus: medial concave depression where renal artery, vein, and ureter enter the kidney
2. Renal sinus: hollow part where urine collects/drains
3. Cortex: external part that forms the renal columns
4. Medulla: internal part with 12-18 medullary pyramids; base faces cortex and papillae extend into calyces
5. Renal pelvis: funnel-shaped reservoir of major and minor calyces that collect urine and funnel it to ureter
6. Nephron: functional unit of the kidney; 1 million per kidney
  - a. Glomeruli: cluster/ball of capillaries, with the filtering membrane forms Bowman's capsule
  - b. Renal tubules
    - (1) Proximal convoluted tubule
    - (2) Descending and ascending - loop of Henle where renin enzyme is secreted
    - (3) Distal convoluted tubule
    - (4) Collecting tubule

#### C. Filtering

1. Blood plasma from renal arteries pass through the glomerular membrane (called filtrate now) to the tubules
2. Tubules select the substances needed by the body and return them to the blood (reabsorption) and waste (urine) is excreted
3. Speed of this process is affected by blood pressure
  - a. Decreased BP = a decreased filtration = decreased output (found in shock)
  - b. Increased BP = kidney damage

### III. Ureters

A. Carry urine from renal pelvis to bladder

B. Anatomy

1. 2 tubes
2. 15-18 inches long, ½ inch diameter
3. Composed of layers: outer fibrous membrane, 2 layers of smooth muscle, mucous membrane lining
4. ureteral orifice: at bladder; prevents reflux of urine in ureters and the renal pelvis

C. Function: urine enters tube every 10 – 30 seconds in spurts due to peristaltic movement

### IV. Bladder

A. Muscle sac that receives and stores urine

B. Anatomy

1. lined with rugae (wrinkles/ridges)
2. Internal sphincter = involuntary
3. External sphincter = voluntary, learned

4. Apex = trigone top
  5. Neck = lower part supported by ligaments
  - C. Function: stores approximately 250 ml. of urine until excreted from body through urethra
  - D. Micturate = emptying bladder (void, urinate)
- V. Urethra
- A. Canal for the excretion of urine from the body
  - B. Anatomy
    1. Female – 1 to 1 ½ inches long; urinary meatus located between the clitoris and the vagina
    2. Male – 8 inches long, passes from bladder through the prostate gland and the penis to the meatus located at the end of the penis; carries both urine and semen
- VI. Urine
- A. Composition
    1. 95% water
    2. 5 % nitrogenous waste, toxins, and mineral salts
  - B. Color: normal = clear, pale amber
    1. Colorless = dilute, found in diabetes insipidus
    2. Dark amber = concentrated, in dehydration, fever
    3. Brown/red = hematuria = blood
    4. Green = all vegetable diet, bile pigments
    5. Others = drugs and other toxins
    6. Milky = fat globules, pus (WBCs and bacteria)
  - C. Amount
    1. Normal = 1000 – 2000 ml excreted in each 24 hours
    2. Oliguria = less than 400 ml/24 hours
      - a. Stress – with stress, hormones increase including ADH (Antidiuretic hormone)
      - b. Hypovolemia
      - c. Disease i.e. eclampsia, acute nephritis
      - d. Obstruction
      - e. Fever
    3. Anuria = less than 75 ml/24 hours
      - a. Obstruction due to retention = uremia
      - b. Metal poisoning
    4. Polyuria = over 2500 ml/24 hours
      - a. Diabetes insipidus
      - b. Diabetes mellitus
      - c. Distention – state of being stretched out
      - d. Diuretics – Lasix, Dyazide
  - D. Aroma (the smell)
    1. Sweet – acetone in diabetes mellitus
    2. Aromatic = bad smell of concentrated urine, gassy foods, certain drugs, etc.
  - E. Abnormalities: UTI, obstruction, drugs, disease

1. Glycosuria: normally no glucose found in urine because it's reabsorbed by proximal tubules
  - a. Stress
  - b. Pregnancy
  - c. Diabetes mellitus (hyperglycemia)
2. Nocturia: excessive urination at night
3. Dysuria: burning sensation/painful urination
  - a. Frequency: increased urge to void
  - b. Urgency: sudden compelling urge to urinate
  - c. Hesitancy: difficulty starting a urine stream
4. Incontinence: uncontrolled passage of urine
  - a. Transient
  - b. Permanent
5. Proteinuria: normal is 10 – 100 mg/24 hours
  - a. Albumin: altered renal function
  - b. Globulin: Bence Jones proteins of multiple myeloma and pyelonephritis
6. Specific gravity (Sp Gr): normal is 1.010 – 1.025
  - a. Measure the weight of a substance (urine) compared with an equal volume of water (1.000)
  - b. High = nephritis, diabetes mellitus
  - c. Low = nephritis
7. Acidity: normal is slightly acidic
  - a. High acid (low pH) = acidosis, fever, starvation
  - b. Alkaline (high pH) = bacterial infection

## VII. Disorders

### A. Glomerulonephritis

1. Etiology - bacterial or toxin (mercury, arsenic, alcohol)
2. Symptoms
  - a. Hematuria
  - b. Proteinuria
  - c. Edema
  - d. Hypertension
  - e. Anorexia
  - f. Flank pain
  - g. Blurred vision
  - h. Smokey urine
  - i. Increased specific gravity
  - j. Headache
3. With infection, immune system responds by forming antibodies. They get trapped in glomeruli and demand kidneys - edema, inflammation, scar tissue
4. Treatment: antibiotics if bacterial; dialysis (external filtering of blood)

### B. Pyelonephritis

1. Etiology: bacterial

2. Symptoms
  - a. Chills and fever – sudden onset
  - b. Flank pain
  - c. Cystitis symptoms: urgency, burning, frequency
3. Treatment: antibiotics, force fluids, NO alcohol
- C. Renal insufficiency
  1. Etiology - arteriosclerosis, atherosclerosis, trauma
  2. Causes anemia: erythropoietin (substance that stimulates production of RBCs) secreted in the kidneys; decrease - decrease in RBCs - anemia

### **Activity**

- I. Complete the Draw the Urinary System activity.
- II. Complete the Urinary System Vocabulary.
- III. Complete the Urinalysis Laboratory Investigation
- IV. Complete the Dialysis Laboratory Investigation
- V. Identify anatomical structures of urinary system on dissected cat.  
(*This can be accomplished as a virtual tour on the internet or if your budget allows, the students can dissect cats.*)

### **Assessment**

Urinary System Quiz

Urinalysis Rubric

Laboratory Investigation Rubric

### **Materials**

Urinary System Terminology

Urinary System Vocabulary

Sheep Kidneys

Dissecting Kits

<http://www.bioedonline.org/>

Utah State Office of Education, (2005). *Medical Anatomy and Physiology Teacher Resource CD*. Utah.

### **Activity I**

Crayons

Colored pencils

### **Activity II**

Urinary System Vocabulary and Key

### **Activity III**

Urinalysis Laboratory Investigation

(modified from “It’s Not Just Water “ lesson

[http://medlabcareers.msu.edu/toolkit%20web/toolkit\\_urin.html](http://medlabcareers.msu.edu/toolkit%20web/toolkit_urin.html))

Mock urine samples (see Recipes section below)  
Specimen cups  
Urine test strips/ Reagent strips with color chart  
Case Scenarios  
Urinalysis Laboratory Data Sheet  
Paper towels, Soft tissue  
Gloves  
Safety glasses, face shield or goggles  
Surface disinfectant and paper towels  
Alcohol-based handrub

Mock Urine Recipes (can be made up the day before and refrigerated)

*Ingredients:*

Mountain Dew (flat)

100 mL of chicken broth (or one cup cooled chicken bouillon made with a bouillon cube or powder); divide for patients 2 through 4

Blood from raw ground beef or turkey (talk to local butcher)

½ percent milk

**Patient #1:** 16 y/o female c/o Polyuria, Polyphagia, Polydipsia, weight loss, blurred vision and fatigue. - Mountain Dew (flat)

**Patient #2:** 65 year old man with severe back pain some abdominal pain, dysuria with some hematuria.– renal lithiasis - Chicken broth/bouillon with just a few drops of blood from raw ground beef or turkey added

**Patient #3:** 18 year old girl with oliguria, dysuria frequent urge to urinate – 5 mL (1 teaspoon) of ½ percent milk added to water or bouillon.

**Patient # 4:** 15 year old male undergoing sports physical – chicken bouillon

**Activity IV**

Materials for Dialysis Laboratory Investigation

Deionized water

Sodium chloride

Glucose

Raw eggs

0.1 M silver nitrate solution

Benedict's solution

1 M nitric acid solution

Bunsen burner

Small test tubes

Droppers

10 ml and 1000 ml graduated cylinders

1000 ml beaker  
500 ml beaker  
Glass rods  
String

Various materials to serve as dialysis membranes (dialysis membrane, cellophane, plastic wrap, wax paper, plastic bag, etc.)  
Gloves  
Goggles  
Biohazard containers  
Surface disinfectant  
Paper towels

**Activity V** Dissection cat, 1 for every 2-4 students, and dissection tools  
AND/OR computers with internet access

### **Urinary System Quiz Key**

Urinary System Diagram

### **Accommodations for Learning Differences**

For reinforcement, students will make flashcards of the anatomical parts of the urinary system with their corresponding function.

For enrichment, students will research and report on a urinary system disease.

### **National and State Education Standards**

National Science Education Standards A9-12; C9-12; F9-12; G9-12

National Health Care Skills Standards .01, .02, .03, .04, .05, .06, .07

National Curriculum Standards for School Mathematics S1; S3; S10; S11

### **TEKS**

130.206 (c)(1) (A) demonstrate safe practices during laboratory and field investigations;

130.206 (c)(1)(B) demonstrate an understanding of the use and conservation of resources and the proper disposal or recycling of materials;

130.206 (c)(2)(A) know the definition of science and understand that it has limitations, as specified in subsection (b)(2) of this section;

130.206 (c)(2)(F) collect and organize qualitative and quantitative data and make measurements with accuracy and precision using tools such as calculators, spreadsheet software, data-collecting probes, computers, standard laboratory glassware, microscopes, various prepared slides, stereoscopes, metric rulers, electronic balances, hand lenses, Celsius thermometers, hot plates, lab notebooks or journals, timing devices, Petri dishes, lab incubators, dissection equipment, meter sticks, and models, diagrams, or samples of biological specimens or structures;

130.206 (c)(2) (H) communicate valid conclusions supported by the data

through methods such as lab reports, labeled drawings, graphic organizers, journals, summaries, oral reports, and technology-based reports;

130.206 (c)(3) (A) in all fields of science, analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing, including examining all sides of scientific evidence of those scientific explanations, so as to encourage critical thinking by the student;

130.206 (c)(3)(B) communicate and apply scientific information extracted from various sources such as current events, news reports, published journal articles, and marketing materials;

130.206 (c)(3)(E) evaluate models according to their limitations in representing biological objects or events;

130.206 (c)(6) (A) investigate and describe the integration of the chemical and physical processes, including equilibrium, temperature, pH balance, chemical reactions, passive transport, active transport, and biofeedback, that contribute to homeostasis;

130.206 (c)(6)(B) determine the consequences of the failure to maintain homeostasis;

130.206 (c)(8) (A) analyze the physical, chemical, and biological properties of transport systems, including circulatory, respiratory, and excretory;

130.206 (c)(8)(B) determine the factors that alter the normal functions of transport systems;

130.206 (c)(8)(C) contrast the interactions among the transport systems;

130.206 (c)(10)(A) analyze the relationships between the anatomical structures and physiological functions of systems, including the integumentary, nervous, skeletal, musculoskeletal, cardiovascular, respiratory, gastrointestinal, endocrine, and reproductive; and

130.206 (c)(10)(B) evaluate the cause and effect of disease, trauma, and congenital defects on the structure and function of cells, tissues, organs, and systems.

## Texas College and Career Readiness Standards

### VI. Biology

#### A. Structure and function of cells

1. Know that although all cells share basic features, cells differentiate to carry out specialized functions.
6. Know the structure of membranes and how this relates to permeability.

#### F. Systems and homeostasis

1. Know that organisms possess various structures and processes (Feedback loops) that maintain steady internal conditions.
2. Describe, compare, and contrast structures and processes that allow gas exchange, nutrient uptake and processing, waste excretion, nervous and hormonal regulation, and reproduction in plants, animals, and fungi; give examples of each.



## **Draw the Urinary System**

Draw the following structures associated with the urinary system. Color and label appropriately.

Include the following:

- Kidneys
- Urinary bladder
- Ureters
- Urethra

("Medical anatomy and," 2005)

# Urinalysis Laboratory Investigation

## Purpose:

In this laboratory investigation, the student will test urine for color, specific gravity, pH, and the presence or absence of glucose, protein, and or ketones.

## Materials:

Mock urine samples  
Specimen cups  
Urine test strips/ Reagent strips with color chart  
Case Scenarios  
Urinalysis Laboratory Data Sheet  
Paper towels  
Soft tissue  
Gloves  
Safety glasses, face shield or goggles  
Surface disinfectant and paper towels  
Alcohol-based handrub

## Urinalysis Laboratory Investigation Scenarios:

For each of the scenarios define the underlined medical terms given and perform the urinalysis lab.

### Patient 1

Isabel is 16 y/o female. She is an athlete and is hardly ever sick. Lately she has been complaining of Polyuria, Polyphagia, Polydipsia, weight loss, blurred vision and fatigue. She has also been having severe itching of the skin. Her doctor has ordered blood tests and a urine sample to be analyzed. Perform the test and document the results.

### Patient 2

Mr. Ben T. Robins is a 65 y/o male. He has been having severe back pain and some abdominal pain for the last two days. This morning he noticed the pain was worse and has been having dysuria with some hematuria. On his visit to the doctor, he was given an order for lab work which included a urine sample. The doctor's order read: KUB and Urinalysis to r/o Renal Lithiasis. Perform the test and document the results.

### Patient 3

Jennifer is 18 years old. She has been having oliguria, dysuria, with the frequent urge to urinate. Her doctor has sent her to the lab for a urinalysis. Perform the test and document the results.

### Patient 4

Michael is 15 y/o male undergoing a sports physical for the swim team. Part of the physical exam includes a urine test. Perform the procedure and document the results.

**Procedure:****A. Determination of Physical Properties**

1. Wash hands
2. Assemble equipment and materials.
3. Prepare work area.
4. Mix specimen by gently swirling.
5. Record clarity (clear, cloudy, hazy, turbid)
6. Record color (straw, yellow, amber, red)
7. Clean work area with surface disinfectant.
8. Remove goggles and gloves and wash hands.

**B. Chemical Examination**

1. Wash hands and put on gloves and goggles.
2. Assemble equipment and materials.
3. Prepare work area.
4. Mix specimen by gently swirling.
5. Remove lid of reagent container and place lid upside down.
6. Lift strip out of container without contaminating.
7. Close reagent container.
8. Dip strip into urine covering all reagent bars without touching rim of urine container.
9. Remove strip immediately and tap against side of container to remove excess urine.
10. Note time on watch or start timer immediately.
11. Read reagent strip
  - a Read pH at correct time and record results.
  - b Read protein at correct time and record results.
  - c Read glucose at correct time and record results.
  - d Read ketones at correct time and record results.
  - e Read blood at correct time and record results.
12. Discard strip appropriately
13. Clean work area with surface disinfectant.
14. Remove goggles and gloves and wash hands.

**C. Microscopic Sediment**

View microscopic sediment images from each sample on the assigned class computer and record observations on worksheet.

**CONCLUSION:**

1. How would the specific gravity of urine be different after a vigorous workout without consuming significant quantities of water?
2. The presence of ketones is often high in the urine of both diabetics and people who suffer from anorexia. What characteristics would these two groups have in common?
3. What factors would contribute to a very high or very low pH in urine?

## Urinalysis Laboratory Student Data Sheet

**Directions:**

1. Perform visual dipstick analysis on each psuedourine sample and record results below.

	<b>Patient #1</b>	<b>Patient #2</b>	<b>Patient #3</b>	<b>Patient #4</b>
	16 y/o female c/o <u>Polyuria</u> , <u>Polyphagia</u> , <u>Polydipsia</u> , weight loss, blurred vision and fatigue.	65 year old man with severe back pain some abdominal pain, <u>dysuria with some hematuria</u> .	18 year old girl with <u>oliguria</u> , <u>dysuria</u> frequent urge to urinate	15 year old male; sample collected during sports physical
Color				
Clarity				
PH				
Specific Gravity				
Protein				
Blood				
Nitrite				
Leukocyte Esterase				
Glucose				
Ketones				
Bilirubin				
Urobilinogen				
Microscopic Sediment				
Clinical Condition				

Adapted from: [http://medlabcareers.msu.edu/toolkit%20web/toolkit\\_urin.html](http://medlabcareers.msu.edu/toolkit%20web/toolkit_urin.html)

## KEY - Urinalysis Laboratory Student Data Sheet

### Directions:

1. Perform visual dipstick analysis on each “fake” urine sample and record results below.
2. View microscopic sediment images from each sample on class computer and record observations on worksheet.

	Patient #1	Patient #2	Patient #3	Patient #4
	14 year old girl with complaints of fatigue and thirst	85 year old man with severe back pain diagnosed with a kidney stone	18 year old girl with frequent urge to urinate	16 year old male; sample collected during sports physical
Color	YELLOW	PINK	STRAW	YELLOW
Clarity	CLEAR	HAZY	CLOUDY	CLEAR
PH	5.0	5.0	5.0 – 6.0	5.0
Specific Gravity	~ 1.015	~ 1.025	~ 1.015 – 1.025	~ 1.015 – 1.020
Protein		TRACE	2+	TRACE
Blood		3+	1+	
Nitrite				
Leukocyte Esterase				
Glucose	1000		NEG TO 100	NEG to 10
Ketones	TRACE			
Bilirubin				
Urobilinogen		0.2		
Microscopic Sediment	SQUAMOUS EPITHELIAL CELLS	RBC'S	WBC'S	MUCUS & HYALINE CASTS
Clinical Condition	Diabetes	Blood in urine (hematuria) due to moving stone.	Urinary Tract Infection	Normal findings

Adapted from: [http://medlabcareers.msu.edu/toolkit%20web/toolkit\\_urin.html](http://medlabcareers.msu.edu/toolkit%20web/toolkit_urin.html)

Student Name: \_\_\_\_\_

## URINALYSIS GRADING RUBRIC

### Grading Rubric:

1. Correct performance of urine dipstick analysis	30 points	_____
2. Neat completion of dipstick analysis worksheet for all five samples	30 points	_____
3. Correct results for each urine sample (N=5)	20 points	_____
4. Correct identification of microscopic cells for each sample.	20 points	_____
5. EXTRA CREDIT: State possible clinical conditions for each sample.	(10 points)	_____
TOTAL POINTS		_____
GRADE = Total Pts/100		_____

## Urinary System Vocabulary

1. Agenesis:	
2. Anuria:	
3. Azotemia:	
4. Cystitis:	
5. Diuresis:	
6. Dysuria:	
7. Ectopic kidney:	
8. Enuresis:	
9. Hypoplastic kidney:	
10. Nephrotic Syndrome:	
11. Oliguria:	
12. Polyuria:	
13. Uremia:	
<b>Disorders / Homeostatic Imbalances</b>	
1. Hematuria:	



2. Edema of Renal Failure:	
3. Renal Failure (Uremia):	
4. Anemia of Kidney Origin:	
5. Developmental Abnormalities:	
6. Glomerulonephritis:	
7. Nephrotic Syndrome:	
8. Arteriolar Nephrosclerosis:	
9. Diabetic nephropathy:	
10. Urinary Tract Infection:	
11. Urinary Tract Calculi (Stones):	
12. Urinary Tract Obstruction:	
13. Renal Tubule Injury:	
14. Congenital Polycystic Kidney Disease:	
15. Tumors:	
16. Wilm's Tumor (Nephroblastoma):	

## Key - Urinary System Vocabulary

1. Agenesis:	absence of one or both kidneys
2. Anuria:	an absence of urine; may be due to kidney failure or to an obstruction in a kidney pathway
3. Azotemia:	presence of urea or other nitrogenous elements in the blood
4. Cystitis:	inflammation of the urinary bladder
5. Diuresis:	an increased production of urine
6. Dysuria:	painful urination
7. Ectopic kidney:	a kidney displaced from its normal position
8. Enuresis:	uncontrolled urination; bed-wetting
9. Hypoplastic kidney:	an undersized kidney
10. Nephrotic Syndrome:	refers to a group of abnormalities characterized by severe loss of protein in the urine resulting in low blood protein levels
11. Oliguria:	a scanty output of urine
12. Polyuria:	an excessive output of urine
13. Uremia:	refers to a toxic level of urea in the blood resulting from kidney malfunction
<b>Disorders / Homeostatic Imbalances</b>	
1. Hematuria:	presence of blood in the urine which may be due to lesions in the Urinary tract; blood originating from the upper portion of the tract might be due to glomerulonephritis (an immunologic reaction), a malignancy, infection, trauma, or a stone; lower tract hemorrhage might be due to infection, malignancy, a stone, or urethritis
2. Edema of Renal Failure:	results when albumin is passed from the blood into urine allowing fluid from blood to flow into the tissues due to loss of osmotic pressure in blood; edema of renal failure is generalized
3. Renal Failure (Uremia):	implies loss of renal function; acute renal failure (sudden loss of renal function) is caused by shock due to prolonged hypertension or hemorrhage; acute renal tubular necrosis is caused by thrombosis, trauma, or acute nephritis; chronic renal failure is due to infections, traumatic vascular, or immunologic diseases; symptoms are nonspecific but can

	include anemia, salt and water retention, hypertension, and toxicity due to retained waste products; treatment is dialysis or transplantation
4. Anemia of Kidney Origin:	arises from severe urinary tract disease due to hematuria or to suppression of bone marrow by chronic renal failure
5. Developmental Abnormalities:	occur more frequently in the kidneys than in any other organs; kidneys can be absent or undersized; they can be displaced from their normal position and extra ureters or renal arteries can be found; the kidneys can fuse giving a horseshoe shape or can be filled with cysts (polycystic renal disease)
6. Glomerulonephritis:	an inflammation of the glomeruli, caused by a hypersensitivity antigen-antibody reaction in the glomeruli; immune-complex or acute glomerulonephritis usually occurs as a complication of a beta streptococci infection or other bacterial or viral infections; anti-GBM nephritis (chronic glomerulonephritis) occurs when autoantibodies are directed against glomerular basement membranes (GBM); renal failure can result from this condition
7. Nephrotic Syndrome:	refers to a group of abnormalities characterized by severe loss of protein in the urine resulting in low blood protein levels; patients show marked leg edema, fluid in the abdomen (ascites), and sometimes fluid in the pleural cavities (hydrothorax)
8. Arteriolar Nephrosclerosis:	occurs in hypertensive patients; their renal arteries undergo thickening, with the glomeruli and tubules undergoing secondary degenerative changes
9. Diabetic nephropathy:	renal damage, usually diffuse thickening of the glomerular basement membranes, called diabetic glomerulosclerosis; there is usually severe sclerosis of the glomerular arterioles; this is a progressive disorder leading to renal failure
10. Urinary Tract Infection:	are usually caused by gram-negative bacteria ascending the urethra; cystitis (bladder infection) causes pain and burning on urination; pyelonephritis (infection of the upper urinary tract) is usually due also to ascending bacteria; stagnation of urine and/or obstruction predisposes individual to the problem
11. Urinary Tract Calculi (Stones):	due to increased concentration of salts in urine (uric acid in gout and calcium salts in hyperparathyroidism); clinical symptoms include renal colic, obstruction, pain, and possibly infection
12. Urinary Tract Obstruction:	blocks urine outflow and leads to progressive dilatation of the urinary tract proximal to the obstruction and eventually causes compression atrophy of the kidneys; common causes include obstruction of bladder neck by enlarged prostate or urethral stricture, calculus, or tumor; complications include stone formation and/or infection
13. Renal Tubule Injury:	may be due to toxic chemicals or to reduced renal blood flow; symptoms include oliguria or anuria; with treatment, tubular function gradually returns

14. Congenital Polycystic Kidney Disease:	transmitted by a Mendelian dominant trait, results from faulty development of the renal tubules and collecting ducts; cysts develop, enlarge, and destroy renal function; this is a relatively common cause of renal failure
15. Tumors:	include adenomas which arise from epithelium or renal tubules, are small, and asymptomatic; carcinomas are more common; transitional cell tumors arise from transitional epithelium lining the urinary tract, are of low-grade malignancy, and have a good prognosis
16. Wilm's Tumor (Nephroblastoma):	an uncommon, highly malignant renal tumor of Infants and children; it arises from embryonic cells in the kidney

# Dialysis Laboratory Investigation

## Purpose:

The purpose of this lab is to determine the permeability of different types of membranes to chloride ions, glucose molecules, and egg albumin. This can be used as a comparison to how the body attempts to maintain homeostasis when changes occur.

## Background Information:

Student should be familiar with the anatomy of the kidneys and how they work. Student should also understand osmosis, diffusion, and related vocabulary such as isotonic, hypertonic, and hypotonic.

## Materials:

Deionized water  
Sodium chloride  
Glucose  
Raw eggs  
0.2 M silver nitrate solution  
Benedict's solution  
1 M nitric acid solution  
Bunsen burner  
Small test tubes  
Droppers  
10 ml and 1000 ml graduated cylinders  
1000 ml beaker  
500 ml beaker  
Glass rods  
String  
Dialysis membranes (Various materials use: dialysis membrane, cellophane, plastic wrap, wax paper, plastic bag, etc.)  
Gloves  
Goggles  
Biohazard containers  
Surface disinfectant  
Paper towels

## Procedure:

- I. Preparation
  - A. Wash hands and put on gloves and goggles.
  - B. Assemble equipment and materials.
  - C. Prepare work area.
  - D. Test solution - add 10 g of sodium chloride, 10 g of glucose, and 10 g of raw egg white to every 500 ml of deionized water needed for the test.

## II. Lab procedure

- A. Create a dialysis bag by placing at least 20 ml of the test solution in each membrane to be tested and secure the solution in the membrane by tying the end with a string. Leave the ends of the string long enough to tie a glass rod to the bag of fluid.
- B. Suspend the glass rod across the mouth of a 500 ml beaker  $\frac{3}{4}$  full of deionized water, allowing the bag to be submersed in the water.
- C. Let stand for at least one hour.
- D. Run the following test on the water in the beaker and on the solution in the dialysis bag. *All tests must be made on all the membrane types. There will be six tests for each membrane-beaker fluid combination.*
  1. Test for sodium chloride -- Pour 5 ml of liquid from the beaker into a test tube and add a drop of 0.1 M silver nitrate. A cloudy formation in the test tube indicates the presence of NaCl.
  2. Test for glucose -- Add 5 ml of Benedict's solution into a test tube; add 5 drops of liquid from the beaker. Gently boil for two minutes over a Bunsen burner or in a water bath. Allow to cool at room temperature. A green, yellow, or red precipitate indicates the presence of glucose.
  3. Test for albumin -- Pour about 5 ml of the liquid from the beaker into a small test tube and add 2-3 drops of 1 M nitric acid. The presence of albumin will be detected by the formation of a white, coagulated precipitate.
  4. Repeat the above tests using 5 mL amounts of solution from the dialysis bags tested.
  5. Clean work area with surface disinfectant. Remove goggles and gloves and wash hands.

### Data:

Record observations

1. Type of membrane: \_\_\_\_\_

	Sodium Chloride	Glucose	Albumin
Contents of dialysis bag			
Water			

2. Type of membrane: \_\_\_\_\_

	Sodium Chloride	Glucose	Albumin
Contents of dialysis bag			
Water			

3. Type of membrane: \_\_\_\_\_

	<b>Sodium Chloride</b>	<b>Glucose</b>	<b>Albumin</b>
Contents of dialysis bag			
Water			

**Conclusion:**

1. Which of the membranes prevented any movement of solute particles?
2. Which membranes allowed the *most* solutes to pass?
3. Which solute particles tested positive most often in the beaker fluid?
4. Can any inference be made about the relative size of the solute particles based upon the results of the tests? If so, what is this inference?
5. Predict the consequences of a change in permeability within the kidney?
6. Compare and contrast acute and chronic renal failure with respect to urinary output, prognosis, and treatment.

## Urinary System Quiz

1. Identify three functions of the urinary system:

- 1.
- 2.
- 3.

2. Identify the four major structures of the urinary system and state their primary function:

- 1.
- 2.
- 3.
- 4.

3. Match the diseases and abnormalities commonly associated with the urinary system with the most appropriate description:

- |                             |                       |                  |
|-----------------------------|-----------------------|------------------|
| A. Incontinence             | B. Diabetes Insipidus | C. Edema         |
| D. Urinary Tract Infections | E. Cystitis           | F. Renal Failure |
| G. Nephritis                | H. Dysuria            | I. Kidney Stones |

- \_\_\_\_\_ 1. Inflammation of the bladder usually occurring secondary to ascending urinary tract infections.
- \_\_\_\_\_ 2. Polyuria and polydipsia caused by inadequate secretion of vasopressin (ADH) by the posterior pituitary gland (Neurohypophysis).
- \_\_\_\_\_ 3. Condition in which body tissues contain an excessive amount of tissue fluid.
- \_\_\_\_\_ 4. The inability to retain urine.
- \_\_\_\_\_ 5. Calculus or crystalline masses present in the pelvis of the kidney composed primarily of urates, oxalates, phosphates, and carbonates of varying size.
- \_\_\_\_\_ 6. Inflammation of the kidney.
- \_\_\_\_\_ 7. Failure of the kidneys to perform their essential functions. Usually less than 10% of total kidney function.
- \_\_\_\_\_ 8. Painful urination.
- \_\_\_\_\_ 9. Infection of the urinary tract (kidneys, ureters, bladder, urethra) by microorganisms.



## Urinary System Quiz - Key

1. Identify three functions of the urinary system:

- 1. Maintains homeostasis by regulating the composition and volume of the blood by removing and restoring selected amounts of water and solutes**
- 2. Maintains blood pressure by influencing plasma volume of the blood**
- 3. Helps in metabolic processes**
  - a. gluconeogenesis during times of starvation**
  - b. secretes erythropoietin which stimulates the production of red blood cells**
  - c. participates in the synthesis of calcitriol (the active form of vitamin D)**

2. Identify the four major structures of the urinary system and state their primary function:

- 1. Kidneys - filters the blood and produces urine**
- 2. Ureters - transports urine to the bladder for storage**
- 3. Bladder - storage site of urine**
- 4. Urethra - passageway for urine from the bladder to the exterior of the body**

3. Match the diseases and abnormalities commonly associated with the urinary system with the most appropriate description:

- |                             |                       |                  |
|-----------------------------|-----------------------|------------------|
| A. Incontinence             | B. Diabetes Insipidus | C. Edema         |
| D. Urinary Tract Infections | E. Cystitis           | F. Renal Failure |
| G. Nephritis                | H. Dysuria            | I. Kidney Stones |

- E 1. Inflammation of the bladder usually occurring secondary to ascending urinary tract infections.
- B 2. Polyuria and polydipsia caused by inadequate secretion of vasopressin (ADH) by the posterior pituitary gland (Neurohypophysis).
- C 3. Condition in which body tissues contain an excessive amount of tissue fluid
- A 4. The inability to retain urine.
- I 5. Calculus or crystalline masses present in the pelvis of the kidney composed primarily of urates, oxalates, phosphates, and carbonates of varying size.
- G 6. Inflammation of the kidney.
- F 7. Failure of the kidneys to perform their essential functions. Usually less than 10% of total kidney function.
- H 8. Painful urination.
- D 9. Infection of the urinary tract (kidneys, ureters, bladder, urethra) by microorganisms.

## Laboratory Investigation Rubric

Student: \_\_\_\_\_

Course: \_\_\_\_\_

Date: \_\_\_\_\_

<b>Scoring Criteria</b>	<b>4</b> <b>Excellent</b>	<b>3</b> <b>Good</b>	<b>2</b> <b>Needs Some Improvement</b>	<b>1</b> <b>Needs Much Improvement</b>	<b>N/A</b>
Problem is appropriately identified.					
Problem is precise, clear, and relevant.					
Association between the problem and the predicted results is direct and relevant.					
All variables are clearly operationalized.					
Demonstrates comprehension of the use of scientific concepts and vocabulary.					
All significant data is measured.					
Data is recorded effectively and efficiently.					
Conclusion relates directly to hypothesis.					
Conclusion has relevancy in resolution of the original problem.					
Conclusion relates the study to general interest.					

## Human Urinary System

