

URINARY SYSTEM

OBJECTIVES/RATIONALE

To pursue a career in health care, proficiency in anatomy and physiology is vital. The students will describe biological and chemical processes that maintain homeostasis; analyze forces and the effects of movement, torque, tension, and elasticity on the human body; associate the disease process with changes in homeostasis; identify changes in structure and function due to trauma and disease; and identify normal and abnormal anatomy and physiology.

TEKS: 121.3 (c)(1)(F)(H),
121.4 (c)(1)(G)(H)(I),
121.5 (c)(1)(E)(F)(G)

TAKS: ELA 1, 4
Mathematics 1, 2, 8
Science 1, 2, 4

KEY POINTS

Powerpoint

- 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

ACTIVITIES

- I. [Urinalysis Laboratory Investigation.](#)
- II. Complete Kidney Dissection.

MATERIALS NEEDED

Kidneys, Kidneys Song
Urinary System Terminology
Urinary System Vocabulary
Sheep Kidneys
Dissecting Kits

ASSESSMENT

Completion of laboratory investigations

ACCOMMODATIONS

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.

REFLECTIONS

KIDNEYS, KIDNEYS

Kidneys, kidneys, filter my body, do
Take the waste away from my bloodstream, too.
I want you at "function normal"
Less than that could be so harmful.
So don't give up, or toxins build up
And my body goes down the tube.

Kidneys, kidneys, help my blood pressure, do
Keep it within normal limits for you.
B/P that's too high is constricting
And kidney damage inflicting
And the R-A-A ---system should stay
Ever working from day to day.

Kidneys, kidneys, please keep on working, do
Renal failure causes its problems, true.
Dialysis can clean blood for me
While I wait for a donor kidney....
And watch what I eat, renal diets aren't so neat
So let's keep renal function complete.

Words by Renae Schumann to the tune of "Daisy, Daisy" 1992

Urinary System Vocabulary

Clinical and Related Terms

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

Disorders / Homeostatic Imbalances

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