GLUCOSE ANALYSIS

OBJECTIVE/RATIONALE

The failure of the body to maintain homeostatic control of glucose will result in diabetes mellitus. The student will learn the technique to test glucose levels in blood and urine.

TEKS 121.15 2B, 2C, 2D, 4A
Algebra II B3A, B1B, B3B

TAKS ELA 1, 4
Mathematics 1, 2, 8, 9
Science 1, 4

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; S5

KEY POINTS

I. Glucose is a monosaccharide that is obtained from the daily carbohydrate intake. Glucose is broken down by the body for energy. Extra glucose is stored in the form of animal fat called glycogen. When the body needs extra energy, the glycogen is broken down through glycogenolysis. Blood glucose levels are maintained though diet and the hormones insulin and glucagon. An increase in blood glucose is called hyperglycemia. A decrease in blood glucose is called hypoglycemia. Hyperglycemia can occur in the disease state diabetes mellitus. Hypoglycemia can occur in Addison's disease.

II. Homeostatic control of blood glucose
   A. Insulin
      1. Produced by beta cells in the islets of Langerhans in the pancreas
      2. Decreases blood sugar concentration
      3. Normal blood sugar concentration is about 80-120 mg of glucose per 100 ml of blood during fasting
      4. Insulin is the only hormone that decreases blood sugar level
      5. The presence of insulin causes a cell's membrane to be more permeable to glucose; this causes blood sugar level to drop in the blood
   B. Glucagon
      1. Produced by alpha cells in the islets of Langerhans in the pancreas
      2. Increases blood sugar concentration
      3. Insulin and glucagon are antagonists; insulin decreases blood sugar level and glucagon increases blood sugar level
      4. Glucocorticoids and growth hormone can also increase blood sugar level

III. Testing of blood glucose level
   A. Principle: The testing is based on the oxidation of glucose with glucose oxidase. When the reaction occurs a brown-colored complex is formed. The

intensity of the color is directly proportional to the glucose concentration in the sample.

B. Specimen: Students can test blood samples or use controls (low control and high control) that are available from chemical companies. If blood samples are used, the serum should be separated from the cells immediatley to stop glycolysis. Specimens should be drawn in sodium fluoride test tubes.

C. Procedure: (Students work in pairs). Prepare the glucose working solution prior to the laboratory investigation (instructions are within the test kit).
   1. Label four test tubes or cuvettes: blank, standard, control, and patient.
   2. Pipette 0.5 mL of distilled water to each tube.
   3. Pipette 25 microliters of distilled water to the blank test tube.
   4. Pipette 25 microliters of standard solution to the standard test tube.
   5. Pipette 25 microliter of the control to the control test tube.
   6. Pipette 25 microliter of the patient serum to the patient test tube.
   7. Pipette 5.0 mL of glucose working solution to each test tube.
   8. Mix each test tube and incubate at room temperature for 45 minutes or at 37 degrees centrigrade for 30 minutes. Protect from light!
   9. Read the absorbance (A) for each tube at 425 to 475 nm against the blank within 30 minutes.

D. Calculations
   1. The formula is as follows:

$$\text{Glucose (mg/dl)} = \frac{A\ (\text{patient or control})}{A\ (\text{standard})} \times (\text{standard value})$$

E. Record results.

ACTIVITIES

I. Complete the **Glucose Laboratory Investigation**.

MATERIALS/RESOURCES

Spectrophotometer
5.0 ml serological pipettes
25 microliter pipette
Water bath
Test tubes or cuvettes
Gloves
Laboratory coat or apron
Quality control specimens: Low and High controls
Patient specimens
Simulated urine kit
Reagent strips
Beaker
Watch with second hand

Goggles
Biohazard containers
Surface disinfectant
Paper towels

Glucose Kit from Sigma, catalog number 510
Sigma Diagnostics
P. O. Box 14508
St. Louis, MO 63178
Tel: 1-800-531-5535
Fax: 1-314-771-5750

Naser, Najih A. and Naser, Saleh A. *Clinical Chemistry Laboratory Manual*. St. Louis: Mosby, Inc. 1998. ISBN0-8151-2581-X

ASSESSMENT

Laboratory Investigation Rubric

ACCOMODATIONS

For reinforcement, the student will review the steps and repeat the laboratory investigation.

For enrichment, the student will compare and contrast gestational, type I, and type II diabetes. Include age of onset, hereditary factors, plasma insulin level, and treatment.

REFLECTIONS

PATHOPHYSIOLOGY
GLUCOSE LABORATORY INVESTIGATION

NAME: DATE:

PURPOSE:
In this laboratory investigation, the student will learn the technique to test glucose levels in blood and urine.

BACKGROUND INFORMATION:

MATERIALS:
Spectrophotometer
5.0 ml serological pipettes
25 microliter pipette
Water bath
Test tubes or cuvettes
Gloves
Laboratory coat or apron
Quality control specimens: Low and High controls
Patient specimens
Simulated urine kit
Reagent strips
Beaker
Watch with second hand
Goggles
Biohazard containers
Surface disinfectant
Paper towels

PROCEDURE:

A. Blood

1. Wash hands and put on gloves and goggles.
2. Assemble equipment and materials.
3. Prepare work area.
4. Label four test tubes or cuvettes: blank, standard, control, and patient.
5. Pipette 0.5 mL of distilled water to each tube.
6. Pipette 25 microliters of distilled water to the blank test tube.
7. Pipette 25 microliters of standard solution to the standard test tube.

8. Pipette 25 microliter of the control to the control test tube.
9. Pipette 25 microliter of the patient serum to the patient test tube.
10. Pipette 5.0 mL of glucose working solution to each test tube.
11. Mix each test tube and incubate at room temperature for 45 minutes or at 37C for 30 minutes. Protect from light!
12. Read the absorbance (A) for each tube at 425 to 475 nm against the blank within 30 minutes.
13. Clean work area with surface disinfectant. Remove goggles and gloves and wash hands.

B. Urine

1. Wash hands and put on gloves and goggles.
2. Assemble equipment and materials.
3. Prepare work area.
4. Obtain urine sample.
5. Gently rotate container to mix specimen. Remove cover.
6. Remove lid of reagent container and place lid upside down. Lift strip out of container without contaminating. Close reagent container.
7. Dip strip into urine covering covering all reagent bars without touching rim of urine container. Remove strip immediately and tap against side of container to remove excess urine.
8. Note time on watch or start timer immediately.
9. Read pH after specified time and record results.
10. Discard of strip appropriately
11. Repeat test for 2 more times.
12. Clean work area with surface disinfectant. Remove goggles and gloves and wash hands.

DATA:

Record the spectrophotometer readings.

A. Blood

TEST TUBE	ABSORBANCE	GLUCOSE mg/dl
Blank		
Standard		
Control		
Patient		

Calculate the blood glucose level with the following calculation:

$$\text{Glucose (mg/dl)} = \frac{A \text{ (patient or control)}}{A \text{ (standard)}} \times \text{(standard value)}$$

Urine

Urine Sample	Results
Sample 1	
Sample 2	
Sample 3	

CONCLUSION:

1. Excess glucose is converted to glycogen by what process?

2. In measuring plasma glucose, the absorbance of the standard used (200mg/dl) was 0.375. The patient sample absorbance was 0.101. Calculate the concentration of the glucose in the patient sample. (Show your work).

3. State the normal range for a blood glucose level.

4. Is the presence of glucose in the urine always indicative of diabetes?

5. How would omission of a meal affect blood glucose levels and insulin balance?

6. Compare and contrast the effects of hypoglycemia and hyperglycemia on the body/