Chapter 45
Clinical Chemistry

Learning Outcomes

Cognitive Domain
1. Spell and define the key terms
2. List the common electrolytes and explain the relationship of electrolytes to acid–base balance
3. Describe the nonprotein nitrogenous compounds and name conditions with abnormal values
4. List and describe the substances commonly tested in liver function assessment
5. Explain thyroid function and the hormone that regulates the thyroid gland
6. Describe how an assessment for a myocardial infarction is made with laboratory tests
7. Describe how pancreatitis is diagnosed with laboratory tests
8. Describe glucose use and regulation and the purpose of the various glucose tests
9. Describe the function of cholesterol and other lipids and their correlation to heart disease

Psychomotor Domain
1. Perform blood glucose testing (Procedure 45-1)
2. Perform blood cholesterol testing (Procedure 45-2)
3. Perform routine maintenance of a glucose meter (Procedure 45-3)
4. Use medical terminology, pronouncing medical terms correctly, to communicate information
5. Perform within scope of practice
6. Practice within the standard of care of a medical assistant
7. Screen test results
8. Analyze charts, graphs, and/or tables in the interpretation of health care results
9. Distinguish between normal and abnormal test results
10. Practice standard precautions
11. Perform handwashing

Affective Domain
1. Distinguish between normal and abnormal test results

ABHES Competencies
1. Perform CLIA-waived tests that assist with diagnosis and treatment
2. Perform chemistry testing
3. Perform routine maintenance of clinical equipment safely
4. Screen and follow up patient test results
5. Use standard precautions
6. Perform CLIA-waived tests
PART IV • The Clinical Laboratory

COG  AFF  MULTIPLE CHOICE

Circle the letter preceding the correct answer.

1. Sodium is used to maintain:
   a. electrolytes.
   b. TSH stimulation.
   c. waste materials.
   d. fluid balance.
   e. blood oxygen.

2. An enzyme is a(n):
   a. cell that speeds up the production of proteins.
   b. protein that quickens chemical reactions.
   c. chemical reaction that ionizes electrolytes.
   d. ion that has an electrical charge.
   e. specialized cell that deals with blood levels.

3. Which of the following is formed in the liver?
   a. Urea
   b. TSH
   c. Creatinine
   d. Lipase
   e. Amylase

4. The kidneys are responsible for:
   a. releasing amylase and lipase into the bloodstream.
   b. ridding the body of waste products.
   c. producing bile and enzymes.
   d. removing worn-out red blood cells.
   e. regulating carbohydrate metabolism.

5. A patient’s blood work shows her amylase level is found to be high. What other substance should you check to test for pancreatitis?
   a. Hemoglobin
   b. Triglycerides
   c. Potassium
   d. Lipase
   e. Lipoproteins

6. The function of LDLs is to:
   a. transport enzymes to the heart and lungs.
   b. assist in the production of lipoproteins.
   c. store energy in adipose tissue.
   d. move cholesterol from the liver to arteries.
   e. carry cholesterol from the cells to the liver.

7. Chloride, bicarbonate, and electrolytes are all a part of:
   a. maintaining thyroid function.
   b. bile formation.
   c. red blood cell maturation.
   d. glucose storage.
   e. acid-base balance.

8. The purpose of TSH is to:
   a. produce hormones in the thyroid gland.
   b. stimulate the thyroid gland.
   c. balance pH levels in the blood.
   d. provide warning of a system failure.
   e. carry cholesterol into the heart.

9. Women are screened for gestational diabetes:
   a. before they conceive.
   b. during the first month of pregnancy.
   c. during the second trimester.
   d. during the third trimester.
   e. after the baby is born.

10. When blood sugar levels go below 45 mg/dL, a person may experience:
    a. trembling.
    b. vomiting.
    c. diarrhea.
    d. chills.
    e. a high temperature.
11. A possible cause of waste-product buildup in the blood is:
   a. liver failure.
   b. renal failure.
   c. pancreatitis.
   d. hypokalemia.
   e. alkalosis.

12. If you are testing for a substance only found in serum, what should you do with a blood specimen?
   a. Use reagent strips to check for serum presence.
   b. Create a slide and analyze it under a microscope.
   c. Put the clotted specimen in the centrifuge to separate.
   d. Allow the specimen a few days to sit and separate.
   e. Run tests without doing anything to the specimen.

13. The pancreas functions in the:
   a. endocrine and exocrine systems.
   b. renal and endocrine systems.
   c. pulmonary and exocrine systems.
   d. digestive and renal systems.
   e. pulmonary and vascular systems.

14. The salivary glands produce:
   a. creatinine.
   b. phosphates.
   c. glucose.
   d. lipase.
   e. amylase.

15. What is the body’s normal pH range?
   a. 6.0 to 6.5
   b. 6.9 to 7.35
   c. 7.0 to 7.5
   d. 7.35 to 7.45
   e. 7.45 to 8.25

16. People who exercise regularly, maintain normal weight, and eat mostly unsaturated fats will probably increase their level of:
   a. HDLs.
   b. LDLs.
   c. albumin.
   d. glucose.
   e. lipase.

17. Hemoglobin A1C is tested to measure the patient’s:
   a. fasting glucose.
   b. level of anemia.
   c. glucose that is attached to hemoglobin molecules.
   d. hemoglobin attached to glucose molecules.
   e. glucose tolerance.

18. Why is fasting required to accurately measure lipid levels?
   a. To evaluate how the body handles fat intake.
   b. To establish fasting glucose levels.
   c. To measure how much water is in body fat levels.
   d. To limit the action of digestion on increasing lipid levels.
   e. To lower HDL levels.

19. What is the number one environmental threat to children?
   a. Lead poisoning.
   b. Carbon monoxide poisoning.
   c. Glue sniffing.
   d. Accidental fires.
   e. High ozone levels.

20. What effect does lead poisoning have on the body?
   a. Limits RBC’s ability to carry oxygen.
   b. Carbon monoxide poisoning.
   c. Increases calcium absorption in bones.
   d. Increases production of blood cells.
   e. Causes uncontrollable bleeding.
## Matching

Match each key term with the correct definition.

### Key Terms

<table>
<thead>
<tr>
<th>Key Terms</th>
<th>Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>21. ____ acidosis</td>
<td>a. electrically charged atoms</td>
</tr>
<tr>
<td>22. ____ alkalosis</td>
<td>b. any substance containing ions</td>
</tr>
<tr>
<td>23. ____ amylase</td>
<td>c. having electrolytes at the right levels</td>
</tr>
<tr>
<td>24. ____ atherosclerosis</td>
<td>d. an electrolyte with a negative charge formed when carbon dioxide dissolves in the blood</td>
</tr>
<tr>
<td>25. ____ azotemia</td>
<td>e. set of chemical reactions that happen to sustain life</td>
</tr>
<tr>
<td>26. ____ bicarbonate</td>
<td>f. keeps the pH changes balanced</td>
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<tr>
<td>27. ____ bile</td>
<td>g. blood pH is below 7.4 caused by too much acid or too little base</td>
</tr>
<tr>
<td>28. ____ buffer systems</td>
<td>h. blood pH is above 7.4 caused by too much base or too little acid</td>
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<tr>
<td>29. ____ catabolism</td>
<td>i. waste product from the body's metabolism of protein</td>
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<tr>
<td>30. ____ creatinine</td>
<td>j. abnormally high levels of nitrogen-containing compounds</td>
</tr>
<tr>
<td>31. ____ electrolyte</td>
<td>k. breaks down fats in the stomach</td>
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<tr>
<td>32. ____ electrolyte balance</td>
<td>l. a protein produced by living cells that speeds up chemical reactions</td>
</tr>
<tr>
<td>33. ____ endocrine</td>
<td>m. patient appears yellow</td>
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<tr>
<td>34. ____ enzyme</td>
<td>n. helps in the digestion of fats</td>
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<tr>
<td>35. ____ exocrine</td>
<td>o. breaks down starch into sugar</td>
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<tr>
<td>36. ____ ions</td>
<td>p. release hormones into the blood in order to cause a response from another organ in the body</td>
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<tr>
<td>37. ____ lipase</td>
<td>q. release enzymes through ducts and include mammary glands, salivary glands, sweat glands, and glands that secrete digestive enzymes into the stomach and intestine</td>
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<tr>
<td>38. ____ lipoproteins</td>
<td>r. substances composed of lipids and proteins</td>
</tr>
<tr>
<td>39. ____ jaundiced</td>
<td>s. buildup of plaques in the arteries</td>
</tr>
<tr>
<td>40. ____ metabolism</td>
<td>t. to break down molecules into smaller units</td>
</tr>
<tr>
<td>41. ____ urea</td>
<td>u. a waste product from making the energy muscles use to function</td>
</tr>
</tbody>
</table>
Identify the electrolyte by the stated relationship to acid–base balance.

**RELATIONSHIP** | **ELECTROLYTE**
--- | ---
42. | It causes the most problems when its level is not stable
43. | When the level is extremely low, it becomes difficult for the patient to breathe
44. | Can be made unstable if the patient is suffering diabetic ketoacidosis and metabolic acidosis
45. | Most important electrolyte used in acid–base balance
46. | Low levels are seen in patients experiencing a long-term severe illness
47. | Low levels result from inadequate absorption from the diet, GI losses, electrolyte shifts, and endocrine disorders
48. | A waste product of oxygen metabolism

The following table lists nonprotein nitrogenous compound descriptions and associated abnormal conditions. Identify the nonprotein nitrogenous compound that is described.

**COMPOUND** | **DESCRIPTION** | **ABNORMAL CONDITION**
--- | --- | ---
49. | Waste product from the body's metabolism of protein | Dehydration, renal disease, inadequate dialysis, azotemia
50. | Waste product from making the energy muscles use to function | Kidney damage, kidney disease
51. | Waste product from breaking down protein | Gout, kidney stones

Identify the substance by its use in liver function assessment.

**RELATIONSHIP** | **SUBSTANCE**
--- | ---
52. | Two of the most useful measures of liver function
53. | Also seen in acute muscle injury
54. | Present in the bones, liver, intestines, kidneys, and placenta
55. | Elevated due to bile duct obstruction and primary biliary cirrhosis
56. | In addition to liver disease, drugs and alcohol cause increased levels
57. | Produced by the normal breakdown of hemoglobin
58. | If this is increased in the blood, it is due to liver disease
59. | Useful when all the liver test results are normal, except the total bilirubin
60. The ___________ gland has two ___________ that lie along the trachea and are joined together by a narrow band of thyroid tissue, known as the ___________. The thyroid gland converts ___________ into thyroid hormones: ___________ and ___________. The bloodstream carries T₃ and T₄ throughout the body where they control ___________.

The thyroid gland is directed by the ___________ gland at the base of the ___________. When the levels of T₃ and T₄ ___________, the pituitary gland is activated to produce ___________. TSH activates the ___________ gland to produce more ___________. This production ___________ the T₃ and T₄ blood levels. When the pituitary senses that the T₃ and T₄ are ___________, it stops its ___________ production. If the thyroid gland is malfunctioning, it cannot be ___________ regardless of the amount of TSH secreted.

61. No one test is completely sensitive and specific for ___________.

62. Comparison of ___________ with patient symptoms and electrocardiograms (EKGs) are important.

63. ___________ is elevated in MI.

64. MI is not the only condition that causes ___________ CK levels.

65. Most of the CK is located in ___________ muscle.

66. CK has three parts: ___________, ___________, and ___________.

67. The ___________ ___________ is present in both cardiac and skeletal muscle.

68. The ___________ ___________ is much more specific for cardiac muscle.

69. The CKMB fraction increases within ___________ following MI.

70. CKMB results indicate heart involvement when they are ___________ of the total CK result.

71. Troponin ___________ are contained in cardiac muscle.

72. They are released into the bloodstream with ___________.

73. Troponins will begin to rise following MI within ___________.

74. ___________ levels are the best indicator of MI.
80. What is pancreatitis, and what two enzymes are elevated in this condition?

81. The pancreas makes two endocrine hormones that are important in diabetes. What are they and what do they do?

82. When you are testing for glucose, what is the puncture site, and why is it important to wash the surrounding area?

83. What are the two hormones that regulate the process of storing glucose as glycogen?
   a. __________________________
   b. __________________________
84. What glucose test is used for screening?

85. What glucose test is used to monitor insulin therapy?

86. Glucose tolerance testing is performed in obstetric patients to diagnose what condition?

87. How does hemoglobin A1C give the physician a picture of the patient's glucose levels over the past 3 months?

88. How are lipoproteins important to our bodies?
89. What are the four fats measured in a lipid panel?

________________________________________

________________________________________

________________________________________

________________________________________

90. What are four major responsibilities of the medical assistant in the chemistry laboratory?

________________________________________

________________________________________

________________________________________

________________________________________

91. You are requested to use medical terminology to communicate information. Break these words down and use the definition of the parts to create a definition for the term.

a. Acidosis

________________________________________

________________________________________

________________________________________

________________________________________

b. Alkalosis

________________________________________

________________________________________

________________________________________

________________________________________
c. Atherosclerosis

d. Catabolism

e. Electrolyte

f. Endocrine

g. Exocrine
1. Your patient is a 5-year-old girl. The physician has ordered a fingerstick glucose. Her mother brings her to the lab for the test. She has given the child a piece of candy because she thought her sugar might be low. You collect the specimen and run the test. The glucose is 60 mg/dl. You realize that you forgot to help the child wash her hands before the test. How could the result be affected if traces of the candy were on the child’s finger? What do you do? What will make it difficult to do the right thing? How do you manage the parent and the child?

2. Your patient, Sarah Ingle, had an electrolyte panel ordered by Dr. Willis. The results are back from the reference lab. Your job is to screen the test results. What are the reference intervals (normal ranges) you expect to see for these tests: sodium, potassium, chloride, and CO₂? You find that the potassium level is 6.0 mmol/L, a panic value. What action do you take, and how do you document your action?
3. Melissa Woermann had a glucose tolerance test. The graph is below. Her fasting glucose was 90 mg/dL. Estimate Ms. Woermann’s 1/2-hour, 1-hour, 2-hour, and 3-hour glucose levels. What are the criteria proposed by the National Diabetes Data Group and the World Health Organization and endorsed by the ADA for a diagnosis of diabetes? Does it appear from the graph that Ms. Woermann could be diagnosed with diabetes?
## PSY PROCEDURE 45-1 Perform Blood Glucose Testing

Name: ________________________ Date: ________ Time: ________ Grade: ________

### EQUIPMENT/SUPPLIES:
- Glucose meter, glucose reagent strips, control solutions, capillary puncture device, personal protective equipment, gauze, paper towel, adhesive bandage, lancet, alcohol pad, hand sanitizer, surface sanitizer, contaminated waste container

### NOTE:
These are generic instructions for using a glucose meter. Refer to the manufacturer’s instructions shipped with the meter for instructions specific to the instrument in use.

### STANDARDS:
Given the needed equipment and a place to work, the student will perform this skill with _______ % accuracy in a total of _______ minutes. (Your instructor will tell you what the percentage and time limits will be before you begin practicing.)

### KEY:
- 4 = Satisfactory
- 0 = Unsatisfactory
- NA = this step is not counted

### PROCEDURE STEPS

<table>
<thead>
<tr>
<th>SELF</th>
<th>PARTNER</th>
<th>INSTRUCTOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Wash your hands. Put on personal protective equipment.</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>2. Assemble the equipment and supplies.</td>
<td>☐</td>
<td>☐</td>
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<tr>
<td>3. Turn on the instrument, and ensure that it is calibrated.</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>4. Perform the test on the quality control material. Record results. Determine whether QC is within control limits. If yes, proceed with patient testing. If no, take corrective action and recheck controls. Document corrective action. Proceed with patient testing when acceptable QC results are obtained.</td>
<td>☐</td>
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<tr>
<td>5. Remove one reagent strip, lay it on the paper towel, and recap the container.</td>
<td>☐</td>
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<tr>
<td>6. Greet and identify the patient. Explain the procedure. Ask for and answer any questions.</td>
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<tr>
<td>7. Have the patient wash his or her hands in warm water.</td>
<td>☐</td>
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<tr>
<td>8. Cleanse the selected puncture site (finger) with alcohol.</td>
<td>☐</td>
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<tr>
<td>9. Perform a capillary puncture, following the steps described in Chapter 41, Phlebotomy. Wipe away the first drop of blood.</td>
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<tr>
<td>10. Turn the patient’s hand palm down, and gently squeeze the finger to form a large drop of blood.</td>
<td>☐</td>
<td>☐</td>
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<tr>
<td>11. Bring the reagent strip up to the finger and touch the pad to the blood.</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>a. Do not touch the finger.</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>b. Completely cover the pad or fill the testing chamber with blood.</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>12. Insert the reagent strip into the analyzer.</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>a. Meanwhile, apply pressure to the puncture wound with gauze.</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>b. The meter will continue to incubate the strip and measure the reaction.</td>
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<tr>
<td>13.</td>
<td>The instrument reads the reaction strip and displays the result on the screen in mg/dL.</td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>Apply a small Band-Aid to the patient's fingertip.</td>
<td></td>
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<tr>
<td>15.</td>
<td>Properly care for or dispose of equipment and supplies.</td>
<td></td>
</tr>
<tr>
<td>16.</td>
<td>Clean the work area. Remove personal protective equipment and wash your hands.</td>
<td></td>
</tr>
</tbody>
</table>

**CALCULATION**

Total Possible Points: ______

Total Points Earned: ______ Multiplied by 100 = ______ Divided by Total Possible Points = ______ %

**PASS** | **FAIL** | **COMMENTS:**
---|---|---
[ | [ | ]

Student's signature ____________________________ Date ______
Partner’s signature ____________________________ Date ______
Instructor’s signature ____________________________ Date ______
### PSY PROCEDURE 45-2 Perform Blood Cholesterol Testing

Name: __________________________ Date: ________ Time: ________ Grade: ________

**EQUIPMENT/SUPPLIES:** Cholesterol meter and supplies or test kit, control solutions, capillary puncture equipment or blood specimen as indicated by manufacturer, personal protective equipment, hand sanitizer, surface sanitizer, contaminated waste container

**NOTE:** These are generic instructions for using a cholesterol meter or test kit. Refer to the manufacturer’s instructions shipped with the testing tool for instructions specific for the instrument in use.

**STANDARDS:** Given the needed equipment and a place to work, the student will perform this skill with ___% accuracy in a total of ______ minutes. *(Your instructor will tell you what the percentage and time limits will be before you begin practicing.)*

**KEY:**
- 4 = Satisfactory  
- 0 = Unsatisfactory  
- NA = this step is not counted

<table>
<thead>
<tr>
<th>PROCEDURE STEPS</th>
<th>SELF</th>
<th>PARTNER</th>
<th>INSTRUCTOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Wash your hands. Put on personal protective equipment.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>2. Assemble the equipment and supplies.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>3. Review instrument manual for your cholesterol meter or test kit.</td>
<td>☐</td>
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<td>☐</td>
</tr>
<tr>
<td>4. Perform the test on the quality control material. Record results. Determine whether QC is within control limits. If yes, proceed with patient testing. If no, take corrective action and recheck controls. Document corrective action. Proceed with patient testing when acceptable QC results are obtained.</td>
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<tr>
<td>5. Obtain patient specimen per manufacturer’s instructions.</td>
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<td>☐</td>
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</tr>
<tr>
<td>6. Perform the testing procedure following the manufacturer’s instructions. Record results.</td>
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<td>☐</td>
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<tr>
<td>7. Properly care for or dispose of equipment and supplies.</td>
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</tr>
<tr>
<td>8. Clean the work area. Remove personal protective equipment and wash your hands.</td>
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</table>
CALCULATION

Total Possible Points: ________

Total Points Earned: ________ Multiplied by 100 = ________ Divided by Total Possible Points = ________ %

PASS       FAIL       COMMENTS:

☐          ☐

Student’s signature ____________________________ Date ______

Partner’s signature ____________________________ Date ______

Instructor’s signature __________________________ Date ______

### Procedure 45-3: Perform Routine Maintenance of a Glucose Meter

**Name:**

**Date:**

**Time:**

**Grade:**

**EQUIPMENT:** Glucose meter, maintenance and testing supplies, manufacturer’s manual for glucose analyzer, control solutions, personal protective equipment, hand sanitizer, surface sanitizer, contaminated waste container

**STANDARDS:** Given the needed equipment and a place to work, the student will perform this skill with ______% accuracy in a total of ________ minutes. (Your instructor will tell you what the percentage and time limits will be before you begin practicing.)

**KEY:**

- 4 = Satisfactory
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- NA = this step is not counted

<table>
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<th>SELF</th>
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<th>INSTRUCTOR</th>
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</thead>
<tbody>
<tr>
<td>1. Wash your hands. Put on gloves.</td>
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</tr>
<tr>
<td>2. Assemble the equipment and supplies.</td>
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</tr>
<tr>
<td>3. Review the instrument manual for your glucose meter.</td>
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<tr>
<td>4. Perform the maintenance procedures listed in the manufacturer’s instructions. Document the performance of these procedures in the instrument maintenance log.</td>
<td>☐</td>
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<tr>
<td>5. Perform the test on the quality control material. Record results.</td>
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<tr>
<td>Determine whether QC is within control limits. If yes, maintenance was successful and instrument is ready for patient testing. If no, take corrective action and recheck controls. Document corrective action. Instrument is available for patient testing when acceptable QC results are obtained.</td>
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<tr>
<td>6. Properly care for or dispose of equipment and supplies.</td>
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<tr>
<td>7. Clean the work area. Remove personal protective equipment, and wash your hands.</td>
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<tr>
<td><em>Note:</em> These are generic instructions for performing routine maintenance of a glucose analyzer. Refer to the manufacturer’s manual for instructions specific to the particular instrument.</td>
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</table>
CALCULATION
Total Possible Points: _______
Total Points Earned: _______ Multiplied by 100 = _______ Divided by Total Possible Points = _______ %

PASS  FAIL  COMMENTS:
☐      ☐

Student’s signature ____________________________ Date ________

Partner’s signature ____________________________ Date ________

Instructor’s signature __________________________ Date ________