

# Laboratory Values

## PYRAMID TERMS

**blood** The liquid pumped by the heart through the arteries, veins, and capillaries. Blood is composed of a clear yellow fluid (plasma), formed elements, and cell types with different functions (Fig. 11-1).

**blood cell** Any of the formed elements of the blood, including red cells (erythrocytes), white cells (leukocytes), and platelets (thrombocytes).

**plasma** The watery, straw-colored, fluid part of lymph and the blood in which the formed elements (blood cells) are suspended. Plasma is made up of water, electrolytes, protein, glucose, fats, bilirubin, and gases and is essential for carrying the cellular elements of the blood through the circulation.

**serum** The clear and thin fluid part of blood that remains after coagulation. Serum contains no blood cells, platelets, or fibrinogen.

**venipuncture** Puncture into a vein to obtain a blood specimen for testing; the antecubital veins are the veins of choice because of ease of access.

a result of the disorder. This process will assist you in determining the correct answer. For example, if the question asks about the immune status of a client receiving chemotherapy, assessment of laboratory values will focus on the white blood cell (WBC) count and the neutrophils. You will need to analyze these results as possibly being low and determine the specific client need, which in this case would be the risk for infection. In the client receiving chemotherapy who has a low WBC count, your plan centers on the immune system and protecting the client from infection. Implementation focuses on preventive interventions related to infection, perhaps protective isolation measures. Evaluation may focus on maintenance of a normal temperature in the client. Box 11-1 lists some of the common abbreviations found in laboratory values. The Priority Nursing Actions box lists the steps needed for obtaining a blood sample.

## CLIENT NEEDS

### Safe and Effective Care Environment

- Applying principles of infection control
- Ensuring surgical asepsis when obtaining a specimen
- Implementing procedures for handling hazardous and infectious materials
- Maintaining standard, transmission-based, and surgical asepsis
- Obtaining informed consent for specific procedures
- Verifying the identity of the client

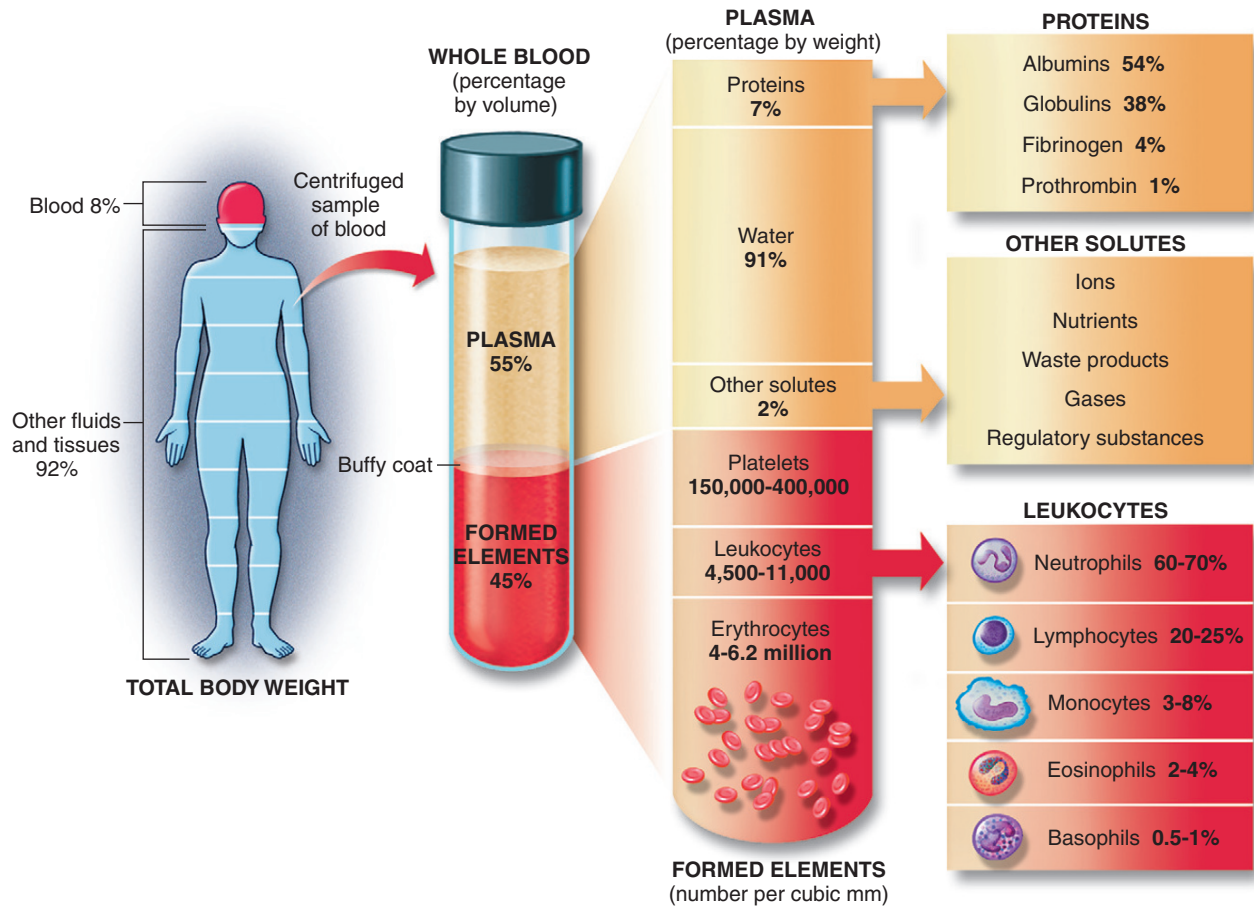
### Health Promotion and Maintenance

- Preparing the client for the laboratory test
- Discussing the importance of follow-up laboratory studies
- Identifying community resources available for the follow-up
- Implementing posttest procedures
- Describing specific interventions or home care measures required based on the results



## THE PYRAMID TO SUCCESS

This chapter identifies the normal adult values for the most common laboratory tests. It is important to remember that normal laboratory values may vary slightly, depending on the laboratory setting and equipment used in testing. If you are familiar with the normal values, you will be able to determine whether an abnormality exists when a laboratory value is presented in a question. The questions on the NCLEX-RN examination related to laboratory values will require you to identify whether the laboratory value is normal or abnormal, and then you are required to think critically about the effects of the laboratory value in terms of the client. Pyramid Points focus on knowledge of the normal values for the most common laboratory tests, therapeutic serum medication levels of commonly prescribed medications, and determination of the need to implement specific actions based on the findings. When a question is presented on the NCLEX-RN examination regarding a specific laboratory value, note the disorder presented in the question and the associated body organ affected as



▲ **FIGURE 11-1** Approximate values for the components of blood in a normal adult. (Modified from Thibodeau, G.A., & Patton, K.T. [2010]. *The human body in health and disease* [5th ed.]. St. Louis: Mosby.)

### Box 11-1 Pyramid Abbreviations

Abbreviation	Definition
g/dL	grams per deciliter
IU/L	International units per liter
mcg/dL	micrograms per deciliter
mcg/mL	micrograms per milliliter
mEq/L	milliequivalents per liter
mg/dL	milligrams per deciliter
microunits/mL	microunits per milliliter
mL/kg	milliliters per kilogram
mm <sup>3</sup>	millimeters cubed
mm/hr	millimeters per hour
ng/mL	nanograms per milliliter
pg/mL	picogram per milliliter
units/L	units per liter
μL	microliters

Monitoring for signs and symptoms that indicate the need to notify the health care provider

### Psychosocial Integrity

Communicating the purpose of the laboratory test to the client

Communicating with the client regarding the laboratory results  
Providing emotional support during testing

### Physiological Integrity

Identifying normal values for the most common laboratory tests  
Identifying therapeutic serum medication levels of commonly prescribed medications  
Monitoring for clinical manifestations associated with an abnormal laboratory value  
Providing comfort measures  
Reporting significant laboratory values  
Determining the significance of an abnormal laboratory value and the need to implement specific actions based on the laboratory results  
Monitoring for potential complications related to a test

⚠ Drawing blood specimens from an extremity in which an intravenous solution is infusing can produce an inaccurate result. Prolonged use of a tourniquet and clenching and unclenching the hand before venous sampling can increase the blood level of potassium, producing an inaccurate result.

### PRIORITY NURSING ACTIONS!

#### Actions to Take When Obtaining a Blood Sample

1. Check physician's prescription.
2. Identify foods, medications, or other factors that may affect the procedure or results.
3. Identify the client.
4. Explain the purpose of the test and procedure to the client.
5. Draw the blood sample.
6. Provide pressure and apply a Band-Aid or gauze dressing to the venipuncture site.
7. Maintain and deliver the specimen to the laboratory according to agency procedure.
8. Document specifics about the procedure.

The nurse should check the physician's prescription for the laboratory test prescribed and then ensure that the client is prepared for the test; for example, that NPO status has been maintained if needed. The nurse would also identify any foods, medications, or other factors that may affect test results. For example, a diet high in fat or leafy vegetables may shorten the prothrombin time. Additionally, there are many medications that can increase or decrease some test results. The nurse then identifies the client and makes sure that the test has been explained to the client. The nurse (or appropriate person as indicated by agency procedure) draws the blood sample, provides pressure, and applies a Band-Aid or gauze dressing to the venipuncture site. Once the client is comfortable, the nurse maintains and delivers the specimen to the laboratory according to agency procedure. The nurse always follows standard and transmission-based precautions as necessary in performing this procedure. The nurse should also check agency guidelines and laboratory manuals regarding the procedure for obtaining the specific blood sample. The nurse then documents the specifics about the procedure.

**Reference:** Pagana, K., & Pagana, T. (2009). *Mosby's diagnostic and laboratory test reference* (9th ed.). St. Louis: Mosby.

**TABLE 11-1** Normal Adult Electrolyte Values

Electrolyte	Value
Sodium	135-145 mEq/L
Potassium	3.5-5.1 mEq/L
Chloride	98-107 mEq/L
Bicarbonate (venous)	22-29 mEq/L

- a. A major intracellular cation, potassium regulates cellular water balance, electrical conduction in muscle cells, and acid-base balance.
- b. The body obtains potassium through dietary ingestion and the kidneys preserve or excrete potassium, depending on cellular need.
- c. Potassium levels are used to evaluate cardiac function, renal function, gastrointestinal function, and the need for IV replacement therapy.

#### 2. Nursing considerations

- a. Note that the client is receiving potassium supplementation on the laboratory form.
- b. Clients with elevated WBC counts and platelet counts may have falsely elevated potassium levels.

#### C. Serum chloride

##### 1. Description

- a. A hydrochloric acid salt that is the most abundant body anion in the extracellular fluid
- b. Functions to counterbalance cations, such as sodium, and acts as a buffer during oxygen and carbon dioxide exchange in red **blood cells** (RBCs)
- c. Aids in digestion and maintaining osmotic pressure and water balance

2. Nursing consideration: Any condition accompanied by prolonged vomiting, diarrhea, or both will alter chloride levels.

#### D. Serum bicarbonate

1. Description: Part of the bicarbonate-carbonic acid buffering system and mainly responsible for regulating the pH of body fluids
2. Nursing consideration: Ingestion of acidic or alkaline solutions may cause increased or decreased results, respectively.

### II. COAGULATION STUDIES

#### A. Activated partial thromboplastin time (aPTT)

##### 1. Description

- a. The aPTT evaluates how well the coagulation sequence is functioning by measuring the amount of time it takes in seconds for recalcified citrated **plasma** to clot after partial thromboplastin is added to it.
- b. The test screens for deficiencies and inhibitors of all factors, except VII and XIII.
- c. Usually, the aPTT is used to monitor heparin therapy and screen for coagulation disorders.

### I. ELECTROLYTES (Table 11-1)

#### A. Serum sodium

##### 1. Description


- a. A major cation of extracellular fluid
- b. Maintains osmotic pressure and acid-base balance, and assists in the transmission of nerve impulses
- c. Is absorbed from the small intestine and excreted in the urine in amounts dependent on dietary intake
- d. Minimum daily requirement of sodium is approximately 15 mEq.

2. Nursing consideration: Drawing **blood** samples in the extremity in which an intravenous (IV) solution of sodium chloride is infusing increases the level, producing an inaccurate result.

#### B. Serum potassium

##### 1. Description


2. Value: 20 to 36 seconds, depending on the type of activator used
3. Nursing considerations
  - a. If the client is receiving intermittent heparin therapy, draw the **blood** sample 1 hour before the next scheduled dose.
  - b. Do not draw samples from an arm into which heparin is infusing.
  - c. Transport specimen to the laboratory immediately.
  - d. Provide direct pressure to the **venipuncture** site for 3 to 5 minutes.
  - e. The aPTT should be between 1.5 and 2.5 times normal when the client is receiving heparin therapy; if the value is prolonged (longer than 90 seconds), the client is at risk for bleeding.

 **If the aPTT value is prolonged (longer than 90 seconds) in a client receiving IV heparin therapy, initiate bleeding precautions.**

## B. Prothrombin time (PT) and international normalized ratio (INR)

1. Description
  - a. Prothrombin is a vitamin K–dependent glycoprotein produced by the liver that is necessary for fibrin clot formation.
  - b. Each laboratory establishes a normal or control value based on the method used to perform the PT test.
  - c. The PT measures the amount of time it takes in seconds for clot formation and is used to monitor response to warfarin sodium (Coumadin) therapy or to screen for dysfunction of the extrinsic clotting system resulting from liver disease, vitamin K deficiency, or disseminated intravascular coagulation.
  - d. A PT value within 2 seconds (plus or minus) of the control is considered normal.
  - e. The INR is a frequently used test to measure the effects of oral anticoagulants.
  - f. The INR standardized the PT ratio and is calculated in the laboratory setting by raising the observed PT ratio to the power of the international sensitivity index specific to the thromboplastin reagent used.
2. Values
  - a. PT: 9.6 to 11.8 seconds (male adult); 9.5 to 11.3 seconds (female adult)
  - b. INR: 2 to 3 for standard warfarin therapy
  - c. INR: 3 to 4.5 for high-dose warfarin therapy
3. Nursing considerations
  - a. A baseline PT should be drawn before anticoagulation therapy is started; note the time of collection on the laboratory form.
  - b. Provide direct pressure to the **venipuncture** site for 3 to 5 minutes.

- c. Concurrent warfarin therapy with heparin therapy can lengthen the PT for up to 5 hours after dosing.
- d. Diets high in green leafy vegetables can increase the absorption of vitamin K, which shortens the PT.
- e. Orally administered anticoagulation therapy usually maintains the PT at 1.5 to 2 times the laboratory control value.
- f. A PT longer than 30 seconds places the client at risk for bleeding.


 **If the PT value is longer than 30 seconds in a client receiving warfarin therapy, initiate bleeding precautions.**

## C. Clotting time

1. Description: The time required for the interaction of all factors involved in the clotting process
2. Value: 8 to 15 minutes
3. Nursing considerations
  - a. The client should not receive heparin therapy for 3 hours before specimen collection because the heparin therapy will affect the results.
  - b. The test result is falsely prolonged by anticoagulant therapy, test tube agitation, or exposure of the specimen to high temperatures.

## D. Platelet count

1. Description
  - a. Platelets function in hemostatic plug formation, clot retraction, and coagulation factor activation.
  - b. Platelets are produced by the bone marrow to function in hemostasis.
2. Value: 150,000 to 400,000 cells/mm<sup>3</sup>
3. Nursing considerations
  - a. Monitor the **venipuncture** site for bleeding in clients with known thrombocytopenia.
  - b. High altitudes, chronic cold weather, and exercise increase platelet counts.
  - c. Bleeding precautions should be instituted in clients with a low platelet count.

 **Monitor the platelet count closely in clients receiving chemotherapy because of the risk for thrombocytopenia.**

## III. ERYTHROCYTE STUDIES

### A. Erythrocyte sedimentation rate

1. Description
  - a. Rate at which erythrocytes settle out of anticoagulated **blood** in 1 hour
  - b. A nonspecific test used to detect illnesses associated with acute and chronic infection, inflammation, advanced neoplasm, and tissue necrosis or infarction

2. Value: 0 to 30 mm/hr, depending on age of client
3. Nursing consideration: Fasting is not necessary, but a fatty meal may cause **plasma** alterations.

#### B. Hemoglobin and hematocrit

1. Description
  - a. Hemoglobin is the main component of erythrocytes and serves as the vehicle for transporting oxygen and carbon dioxide.
  - b. Hemoglobin determinations are important in identifying anemia.
  - c. Hematocrit represents RBC mass and is an important measurement in the identification of anemia or polycythemia (Table 11-2).
2. Nursing consideration: Fasting is not required.

#### C. Serum iron

1. Description
  - a. Iron is found predominantly in hemoglobin.
  - b. Iron acts as a carrier of oxygen from the lungs to the tissues and indirectly aids in the return of carbon dioxide to the lungs.
  - c. Iron aids in diagnosing anemias and hemolytic disorders.
2. Normal values
  - a. Male adult: 65 to 175 mcg/dL
  - b. Female adult: 50 to 170 mcg/dL
3. Nursing consideration: Level of iron will be increased if the client has ingested iron before the test.

#### D. RBC count (erythrocytes)

1. Description
  - a. RBCs function in hemoglobin transport, which results in delivery of oxygen to the body tissues.
  - b. RBCs are formed by red bone marrow, have a life span of 120 days, and are removed from the **blood** via the liver, spleen, and bone marrow.
  - c. The RBC count aids in diagnosing anemias and **blood** dyscrasias.
  - d. The RBC count evaluates the ability of the body to produce RBCs in sufficient numbers.

**TABLE 11-2** Normal Adult Blood Components

Blood Component	Normal Value
<b>HEMOGLOBIN</b>	
Male adult	14-16.5 g/dL
Female adult	12-15 g/dL
<b>HEMATOCRIT</b>	
Male adult	42%-52%
Female adult	35%-47%
<b>IRON</b>	
Male adult	65-175 mcg/dL
Female adult	50-170 mcg/dL
<b>RED BLOOD CELLS</b>	
Male adult	4.5-6.2 million/ $\mu$ L
Female adult	4-5.5 million/ $\mu$ L

2. Values
  - a. Female adult: 4 to 5.5 million cells/ $\mu$ L
  - b. Male adult: 4.5 to 6.2 million cells/ $\mu$ L
3. Nursing consideration: Fasting is not required.

#### IV. SERUM ENZYMES AND CARDIAC MARKERS (Table 11-3)

##### A. Creatine kinase (CK)

1. Description
  - a. Creatine kinase is an enzyme found in muscle and brain tissue that reflects tissue catabolism resulting from cell trauma.
  - b. The CK level begins to rise within 6 hours of muscle damage, peaks at 18 hours, and returns to normal in 2 to 3 days.
  - c. The test for CK is performed to detect myocardial or skeletal muscle damage or central nervous system damage; a normal CK value is 26 to 174 units/L.
  - d. Isoenzymes include CK-MB (cardiac), CK-BB (brain), and CK-MM (muscles).
  - e. Isoenzyme CK-MB is found mainly in cardiac muscle, CK-BB is found mainly in brain tissue, and CK-MM is found mainly in skeletal muscle.

**TABLE 11-3** Normal Adult Serum Enzymes/Cardiac Markers

Serum Enzyme	Normal Value
Creatine kinase (CK)	26-174 units/L
CK isoenzymes	
CK-MB	0%-5% of total
CK-MM	95%-100% of total
CK-BB	0%
Lactate dehydrogenase	140-280 units/L
Lactate dehydrogenase isoenzymes	
LDH1	14%-26%
LDH2	29%-39%
LDH3	20%-26%
LDH4	8%-16%
LDH5	6%-16%
Troponin I	<0.6 ng/mL; >1.5 ng/mL indicates myocardial infarction
Troponin T	>0.1-0.2 ng/mL indicates myocardial infarction
Myoglobin	<90 mcg/L; elevation could indicate myocardial infarction
Atrial natriuretic peptides (ANP)	22 to 27 pg/mL
Brain natriuretic peptides (BNP)	Less than 100 pg/mL
C-type natriuretic peptides (CNP)	Not yet determined; reference range provided with results and should be reviewed

## 2. Values

- a. CK-MB: 0% to 5% of total
- b. CK-MM: 95% to 100% of total
- c. CK-BB: 0%

## 3. Nursing considerations

- a. If the test is to evaluate skeletal muscle, instruct the client to avoid strenuous physical activity for 24 hours before the test.
- b. Also instruct the client to avoid ingestion of alcohol for 24 hours before the test.
- c. Invasive procedures and intramuscular injections may falsely elevate CK levels.

**B. Lactate dehydrogenase (LDH)**

## 1. Description

- a. The LDH isoenzymes affected by acute myocardial infarction are LDH1 and LDH2.
- b. The LDH level begins to rise about 24 hours after myocardial infarction and peaks in 48 to 72 hours; thereafter, it returns to normal, usually within 7 to 14 days.
- c. The presence of an LDH flip (when LDH1 is higher than LDH2) is helpful in diagnosing a myocardial infarction.

## 2. Nursing considerations

- a. The LDH isoenzyme levels should be interpreted in view of the clinical findings.
- b. Testing should be repeated on 3 consecutive days.

**C. Troponins**

## 1. Description

- a. Troponin is a regulatory protein found in striated muscle (skeletal and myocardial).
- b. Increased amounts of troponins are released into the bloodstream when an infarction causes damage to the myocardium.
- c. Levels elevate as early as 3 hours after myocardial injury. Troponin I levels may remain elevated for 7 to 10 days and troponin T levels may remain elevated for as long as 10 to 14 days.
- d. Serial measurements are important to compare with a baseline test.

## 2. Values

- a. Troponin I: Value usually is lower than 0.6 ng/mL; value higher than 1.5 ng/mL is consistent with a myocardial infarction.
- b. Troponin T: Higher than 0.1 to 0.2 ng/mL is consistent with a myocardial infarction.

## 3. Nursing considerations

- a. Testing is repeated in 12 hours, followed by daily testing for 3 to 5 days.
- b. Rotate **venipuncture** sites.

**D. Myoglobin**

## 1. Description

- a. Myoglobin is an oxygen-binding protein that is found in striated (cardiac and skeletal) muscle that releases oxygen at very low tensions.

- b. Any injury to skeletal muscle will cause a release of myoglobin into the **blood**.

2. Values: Normal value is lower than 90 mcg/L; an elevation could indicate myocardial infarction.

## 3. Nursing considerations

- a. The level can rise as early as 2 hours after a myocardial infarction, with a rapid decline in the level after 7 hours.
- b. Because the myoglobin level is not cardiac-specific and rises and falls so rapidly, its use in diagnosing myocardial infarction may be limited.

**E. Natriuretic peptides**

## 1. Description

- a. Natriuretic peptides are neuroendocrine peptides that are used to identify clients with congestive heart failure (CHF).
- b. There are three major peptides: atrial natriuretic peptides (ANP) synthesized in cardiac atrial muscle, brain natriuretic peptides (BNP) synthesized in cardiac ventricle muscle, and C-type natriuretic peptides (CNP) synthesized by endothelial cells
- c. BNP is the primary marker for identifying CHF as the cause of dyspnea.

## 2. Values:

- a. ANP: 22 to 27 pg/mL
- b. BNP: less than 100 pg/mL
- c. CNP: not yet determined

## 3. Nursing consideration: Fasting is not required.

**!** The higher the BNP level, the more severe the CHF. If the BNP is elevated the dyspnea is due to CHF; if it is normal the dyspnea is due to a pulmonary problem.

**V. SERUM GASTROINTESTINAL STUDIES****A. Albumin**

## 1. Description

- a. A main **plasma** protein of **blood**
- b. Maintains oncotic pressure and transports bilirubin, fatty acids, medications, hormones, and other substances that are insoluble in water
- c. Increased in conditions such as dehydration, diarrhea, and metastatic carcinoma; decreased in conditions such as acute infection, ascites, and alcoholism
- d. Presence of detectable albumin, or protein, in the urine is indicative of abnormal renal function

## 2. Value: 3.4 to 5 g/dL

## 3. Nursing consideration: Fasting is not required.

**B. Alkaline phosphatase**

## 1. Description

- a. Alkaline phosphatase is an enzyme normally found in bone, liver, intestine, and placenta.

- b. The level rises during periods of bone growth, liver disease, and bile duct obstruction.
- 2. Value: 4.5 to 13 King-Armstrong units/dL
- 3. Nursing considerations
  - a. The client may need to fast 12 hours before the test.
  - b. Hepatotoxic medications administered within 12 hours before specimen collection can cause a falsely elevated value.
  - c. Transport the specimen to the laboratory immediately.

### C. Ammonia

- 1. Description
  - a. Ammonia is a byproduct of protein catabolism; most of it is created by bacteria acting on proteins present in the gut.
  - b. Ammonia is metabolized by the liver and excreted by the kidneys as urea.
  - c. Elevated levels resulting from hepatic dysfunction may lead to encephalopathy.
  - d. Venous ammonia levels are not a reliable indicator of hepatic coma.
- 2. Value: 10 to 80 mcg/dL
- 3. Nursing considerations
  - a. Instruct the client to fast, except for water, and to refrain from smoking for 8 to 10 hours before the test; smoking increases ammonia levels.
  - b. Place the specimen on ice and transport to the laboratory immediately.

### D. Alanine aminotransferase (ALT)

- 1. Description: Used to identify hepatocellular disease of the liver and to monitor improvement or worsening of the disease.
- 2. Value: 4 to 6 international units/L
- 3. Nursing considerations
  - a. Previous intramuscular injections may cause elevated levels.
  - b. No fasting is required.

### E. Aspartate aminotransferase (AST)

- 1. Description: Used to evaluate a client with suspected hepatocellular disease (may also be used along with other cardiac markers to evaluate coronary artery occlusive disease)
- 2. Value: 0 to 35 units/L
- 3. Nursing considerations
  - a. Previous intramuscular injections may cause elevated levels
  - b. No fasting is required.

### F. Amylase

- 1. Description
  - a. This enzyme, produced by the pancreas and salivary glands, aids in the digestion of complex carbohydrates and is excreted by the kidneys.
  - b. In acute pancreatitis, the amylase level is greatly increased; the level starts rising 3 to

6 hours after the onset of pain, peaks at about 24 hours, and returns to normal in 2 to 3 days after the onset of pain.

- 2. Value: 25 to 151 units/L
- 3. Nursing considerations
  - a. On the laboratory form, list the medications that the client has taken during the previous 24 hours before the test.
  - b. Note that many medications may cause false-positive or false-negative results.
  - c. Results are invalidated if the specimen was obtained less than 72 hours after cholecystography with radiopaque dyes.

### G. Lipase

- 1. Description
  - a. This pancreatic enzyme converts fats and triglycerides into fatty acids and glycerol.
  - b. Elevated lipase levels occur in pancreatic disorders; elevations may not occur until 24 to 36 hours after the onset of illness and may remain elevated for up to 14 days.
- 2. Value: 10 to 140 units/L
- 3. Nursing considerations: Endoscopic retrograde cholangiopancreatography (ERCP) may increase lipase activity.

### H. Bilirubin

- 1. Description
  - a. Bilirubin is produced by the liver, spleen, and bone marrow and is also a byproduct of hemoglobin breakdown.
  - b. Total bilirubin levels can be broken down into direct bilirubin, which is excreted primarily via the intestinal tract, and indirect bilirubin, which circulates primarily in the bloodstream.
  - c. Total bilirubin levels increase with any type of jaundice; direct and indirect bilirubin levels help differentiate the cause of the jaundice.
- 2. Values
  - a. Bilirubin, direct (conjugated): 0 to 0.3 mg/dL
  - b. Bilirubin, indirect (unconjugated): 0.1 to 1 mg/dL
  - c. Bilirubin, total: Lower than 1.5 mg/dL
- 3. Nursing considerations
  - a. Instruct the client to eat a diet low in yellow foods, avoiding foods such as carrots, yams, yellow beans, and pumpkins, for 3 to 4 days before the **blood** is drawn.
  - b. Instruct the client to fast for 4 hours before the **blood** is drawn.
  - c. Note that results will be elevated with the ingestion of alcohol or the administration of morphine sulfate, theophylline, ascorbic acid (vitamin C), or acetylsalicylic acid (aspirin).
  - d. Note that results are invalidated if the client has received a radioactive scan within 24 hours before the test.

- I. Lipids**
- Description
    - Blood** lipids consist primarily of cholesterol, triglycerides, and phospholipids.
    - Lipid assessment includes total cholesterol, high-density lipoprotein (HDL), low-density lipoprotein (LDL), and triglycerides.
    - Cholesterol is present in all body tissues and is a major component of LDLs, brain and nerve cells, cell membranes, and some gall-bladder stones.
    - Triglycerides constitute a major part of very low-density lipoproteins and a small part of LDLs.
    - Triglycerides are synthesized in the liver from fatty acids, protein, and glucose, and are obtained from the diet.
    - Increased cholesterol levels, LDL levels, and triglyceride levels place the client at risk for coronary artery disease.
    - HDL helps protect against the risk of coronary artery disease.
  - Values:
    - Cholesterol: 140 to 199 mg/dL
    - Low-density lipoproteins: Lower than 130 mg/dL
    - HDLs: 30 to 70 mg/dL
    - Triglycerides: Lower than 200 mg/dL
  - Nursing considerations
    - Oral contraceptives may increase the lipid level.
    - Instruct the client to abstain from foods and fluid, except for water, for 12 to 14 hours and from alcohol for 24 hours before the test.
    - Instruct the client to completely avoid high-cholesterol foods with the evening meal before the test.
- J. Protein**
- Description
    - Protein reflects the total amount of albumin and globulins in the **plasma**.
    - Protein regulates osmotic pressure and is necessary for the formation of many hormones, enzymes, and antibodies; it is a major source of building material for blood, skin, hair, nails, and internal organs.
    - Increased in conditions such as Addison's disease, autoimmune collagen disorders, chronic infection, and Crohn's disease.
    - Decreased in conditions such as burns, cirrhosis, edema, and severe hepatic disease.
  - Value: 6 to 8 g/dL
  - Nursing considerations: Instruct the client to avoid a high-fat diet for 8 hours before the test.
- K. Uric acid**
- Description
    - Uric acid is formed as the purines adenine and guanine are metabolized continuously during the formation and degradation of DNA and RNA. It is also formed from the metabolism of dietary purines.
    - Elevated amounts of uric acid deposit in joints and soft tissue and cause gout.
    - Conditions of increased cellular turnover, as well as slowed renal excretion of uric acid, may cause hyperuricemia.
    - Elevated levels of urinary uric acid precipitate into urate stones in the kidneys.
  - Values
    - Male adult: 4.5 to 8 mg/dL
    - Female adult: 2.5 to 6.2 mg/dL
  - Nursing considerations
    - Instruct the client to fast for 8 hours before the test.
    - Theophylline, caffeine, and vitamin C may cause falsely elevated results.
- ! Clients with liver disease often have prolonged clotting times; therefore, provide prolonged pressure at the venipuncture site and monitor the site closely for bleeding.**

## VI. GLUCOSE STUDIES

- A. Fasting blood glucose**
- Description
    - Glucose is a monosaccharide found in fruits and is formed from the digestion of carbohydrates and the conversion of glycogen by the liver.
    - Glucose is the main source of cellular energy for the body and is essential for brain and erythrocyte function.
    - Fasting **blood** glucose levels are used to help diagnose diabetes mellitus and hypoglycemia (Table 11-4).
  - Nursing considerations
    - Instruct the client to fast for 8 to 12 hours before the test.
    - Instruct a client with diabetes mellitus to withhold morning insulin or oral hypoglycemic medication until after the **blood** is drawn.

**TABLE 11-4** Normal Adult Glucose Values

Measurement Setting	Normal Value
Glucose, fasting	70-110 mg/dL
Glucose monitoring (capillary blood)	60-110 mg/dL
Glucose tolerance test, oral	
Baseline fasting	70-110 mg/dL
30-min fasting	110-170 mg/dL
60-min fasting	120-170 mg/dL
90-min fasting	100-140 mg/dL
120-min fasting	70-120 mg/dL
Glucose, 2-hr postprandial	<140 mg/dL



**B. Glucose tolerance test (see Table 11-4)**

1. Description
  - a. The glucose tolerance test aids in the diagnosis of diabetes mellitus.
  - b. If the glucose levels peak at higher than normal at 1 and 2 hours after injection or ingestion of glucose and are slower than normal to return to fasting levels, then diabetes mellitus is confirmed.
2. Nursing considerations
  - a. Instruct the client to eat a high-carbohydrate (200- to 300-g) diet for 3 days before the test.
  - b. Instruct the client to avoid alcohol, coffee, and smoking for 36 hours before the test.
  - c. Instruct the client to fast for 10 to 16 hours before the test.
  - d. Instruct the client to avoid strenuous exercise for 8 hours before and after the test.
  - e. Instruct the client with diabetes mellitus to withhold morning insulin or oral hypoglycemic medication.
  - f. Instruct the client that the test may take 3 to 5 hours, requires IV or oral administration of glucose, and multiple **blood** samples.

**C. Glycosylated hemoglobin**

1. Description
  - a. Glycosylated hemoglobin is **blood** glucose bound to hemoglobin.
  - b. Hemoglobin A<sub>1c</sub> (glycosylated hemoglobin A; HbA<sub>1c</sub>) is a reflection of how well **blood** glucose levels have been controlled for the past 3 to 4 months.
  - c. Hyperglycemia in clients with diabetes is usually a cause of an increase in the HbA<sub>1c</sub>.
2. Values
  - a. Values are expressed as a percentage of the total hemoglobin.
  - b. Good control of diabetes: 7% or lower
  - c. Fair control of diabetes: 7% to 8%
  - d. Poor control of diabetes: Higher than 8%
3. Nursing consideration: Fasting is not required before the test.

**D. Glycosylated serum albumin (fructosamine)**

1. Description
  - a. Reflects average **serum** glucose levels over a period of 2 to 3 weeks
  - b. More sensitive to recent changes than the HbA<sub>1c</sub>
2. Values: Normal ranges vary according to method of testing used; nondiabetic client, 1.5 to 2.7 mmol/L; diabetic client, 2 to 5 mmol/L.
3. Nursing consideration: The client needs to fast for 12 hours before the test.

**E. Diabetes mellitus autoantibody panel**

1. Description: Used to evaluate insulin resistance and to identify type 1 diabetes and clients with a suspected allergy to insulin
2. Value: Less than 1:4 titer with no antibody detected

## 3. Nursing considerations

- a. Radioactive scans within 7 days before the test may interfere with test results.
- b. No fasting is required.

**VII. RENAL FUNCTION STUDIES****A. Serum creatinine**

1. Description
  - a. Creatinine is a specific indicator of renal function.
  - b. Increased levels of creatinine indicate a slowing of the glomerular filtration rate.
2. Value: 0.6 to 1.3 mg/dL
3. Nursing consideration: Instruct the client to avoid excessive exercise for 8 hours and excessive red meat intake for 24 hours before the test.

**B. Blood urea nitrogen**

1. Description
  - a. Urea nitrogen is the nitrogen portion of urea, a substance formed in the liver through an enzymatic protein breakdown process.
  - b. Urea is normally freely filtered through the renal glomeruli, with a small amount reabsorbed in the tubules and the remainder excreted in the urine.
  - c. Elevated levels indicate a slowing of the glomerular filtration rate.
2. Value: 8 to 25 mg/dL
3. Nursing consideration: Creatinine and urea nitrogen levels should be analyzed when renal function is evaluated.

**VIII. ELEMENTS****A. Calcium**

1. Description
  - a. Calcium is a cation absorbed into the bloodstream from dietary sources and functions in bone formation, nerve impulse transmission, and contraction of myocardial and skeletal muscles.
  - b. Calcium aids in **blood** clotting by converting prothrombin to thrombin.
2. Value: 8.6 to 10 mg/dL
3. Nursing considerations
  - a. Instruct the client to eat a diet with a normal calcium level (800 mg/day) for 3 days before the test.
  - b. Instruct the client that fasting may be required for 8 hours before the test.

**B. Magnesium**

1. Description
  - a. Magnesium is used as an index to determine metabolic activity and renal function.
  - b. Magnesium is needed in the **blood**-clotting mechanism, regulates neuromuscular activity, acts as a cofactor that modifies the activity of many enzymes, and has an effect on the metabolism of calcium.

2. Value: 1.6 to 2.6 mg/dL
3. Nursing considerations
  - a. Prolonged use of magnesium products causes increased **serum** levels.
  - b. Long-term parenteral nutrition therapy or excessive loss of body fluids may decrease **serum** levels.

### C. Phosphorus

1. Description
  - a. Phosphorus is important in bone formation, energy storage and release, urinary acid-base buffering, and carbohydrate metabolism.
  - b. Phosphorus is absorbed from food and is excreted by the kidneys.
  - c. High concentrations of phosphorus are stored in bone and skeletal muscle.
2. Value: 2.7 to 4.5 mg/dL
3. Nursing considerations: Instruct the client to fast before the test.

## IX. THYROID STUDIES

### A. Description

1. Thyroid studies are performed if a thyroid disorder is suspected.
2. Thyroid studies help differentiate primary thyroid disease from secondary causes and from abnormalities in thyroxine-binding globulin levels.

### B. Values

1. Thyroid-stimulating hormone (also called thyrotropin): 0.2 to 5.4 microunits/mL
2. Thyroxine ( $T_4$ ): 5 to 12 mcg/dL
3. Thyroxine, free ( $FT_4$ ): 0.8 to 2.4 ng/dL
4. Triiodothyronine ( $T_3$ ): 80 to 230 ng/dL

- ### C. Nursing consideration: Test results may be invalid if the client has undergone a radionuclide scan within 7 days before the test.

## X. WHITE BLOOD CELL COUNT

### A. Description

1. WBCs function in the immune defense system of the body.
2. The WBC count assesses leukocyte distribution.


- ### B. Value: 4500 to 11,000 cells/mm<sup>3</sup> (Table 11-5)

**TABLE 11-5** Normal Adult White Blood Cell Differential Count

Cell Type	Count
Neutrophils	1800-7800 cells/mm <sup>3</sup>
Bands	0-700 cells/mm <sup>3</sup>
Eosinophils	0-450 cells/mm <sup>3</sup>
Basophils	0-200 cells/mm <sup>3</sup>
Lymphocytes	1000-4800 cells/mm <sup>3</sup>
Monocytes	0-800 cells/mm <sup>3</sup>

### C. Nursing considerations

1. A “shift to the left” means that an increased number of immature neutrophils is present in the **blood**.
2. A low total WBC count with a left shift indicates a recovery from bone marrow depression or an infection of such intensity that the demand for neutrophils in the tissue is higher than the capacity of the bone marrow to release them into the circulation.
3. A high total WBC count with a left shift indicates an increased release of neutrophils by the bone marrow in response to an overwhelming infection or inflammation.
4. A “shift to the right” means that cells have more than the usual number of nuclear segments; found in liver disease, Down syndrome, and megaloblastic and pernicious anemia.

 Monitor the WBC count closely in clients receiving chemotherapy because of the risk for neutropenia.

## XI. HEPATITIS TESTING

### A. Description

1. Tests include radioimmunoassay, enzyme-linked immunosorbent assay (ELISA), and microparticle enzyme immunoassay.
2. Serological tests for specific hepatitis virus markers assist in defining the specific type of hepatitis.

### B. Values

1. The presence of immunoglobulin M (IgM) antibody to hepatitis A virus and the presence of the total antibody to hepatitis A virus identify the disease.
2. Detection of hepatitis B core antigen (HBcAg), envelope antigen (HBeAg), and surface antigen (HBsAg), or their corresponding antibodies, constitutes hepatitis B assessment.
3. Hepatitis C is confirmed by the presence of antibodies to hepatitis C virus.
4. Serological hepatitis D virus determination is made by detection of the hepatitis D antigen (HDAg) early in the course of the infection and by detection of anti-hepatitis D virus antibody in the later disease stages.
5. Specific serological tests for hepatitis E virus include detection of IgM and IgG antibodies to hepatitis E.
6. Hepatitis G virus has been found in some **blood** donors (donated **blood**), IV drug users, hemodialysis clients, and clients with hemophilia; however, hepatitis G virus does not appear to cause significant liver disease.

- ### C. Nursing consideration: If the radioimmunoassay technique is being used, the injection of radionuclides within 1 week before the **blood** test is performed may cause falsely elevated results.



## XII. HUMAN IMMUNODEFICIENCY VIRUS (HIV) AND ACQUIRED IMMUNODEFICIENCY SYNDROME (AIDS) TESTING

### A. Description

1. Testing detects HIV, which is the cause of AIDS.
2. Common tests used to determine the presence of antibodies to HIV include ELISA, Western blot, and immunofluorescence assay (IFA).
3. A single reactive ELISA test by itself cannot be used to diagnose HIV and should be repeated in duplicate with the same **blood** sample; if the result is repeatedly reactive, follow-up tests using Western blot or IFA should be performed.
4. A positive Western blot or IFA result is considered confirmatory for HIV.
5. A positive ELISA result that fails to be confirmed by Western blot or IFA should not be considered negative, and repeat testing should take place in 3 to 6 months.

### B. CD4<sup>+</sup> T-cell counts

1. Monitors the progression of HIV
2. As the disease progresses, usually the number of CD4<sup>+</sup> T-cells decreases, with a resultant decrease in immunity.
3. Normal CD4<sup>+</sup> T-cell count is between 500 and 1600 cells/L.
4. Generally, the immune system remains healthy with CD4<sup>+</sup> T-cell counts higher than 500 cells/L.
5. Immune system problems occur when the CD4<sup>+</sup> T-cell count is between 200 and 499 cells/L.
6. Severe immune system problems occur when the CD4<sup>+</sup> T-cell count is lower than 200 cells/L.

### C. CD4-to-CD8 ratio

1. Monitors progression of disease.
2. Normal ratio is approximately 2:1.

### D. Viral culture involves placing the infected client's **blood cells** in a culture medium and measuring the amount of reverse transcriptase activity over a specified period of time.

### E. Viral load testing measures the presence of HIV viral genetic material (RNA) or another viral protein in the client's **blood**.

### F. The p24 antigen assay quantifies the amount of HIV viral core protein in the client's **serum**.

### G. Oral testing for HIV

1. Uses a device that is placed against the gum and cheek for 2 minutes
2. Fluid (not saliva) is drawn into an absorbable pad, which, in an HIV-positive individual, contains antibodies.
3. The pad is placed in a solution and a specified observable change is noted if the test result is positive.

**TABLE 11-6** Normal Adult Values: Urine Tests

Name of Test	Value
Color	Pale yellow
Odor	Specific aromatic odor, similar to ammonia
Turbidity	Clear
pH	4.5-7.8
Specific gravity	1.016 to 1.022
Glucose	<0.5 g/day
Ketones	None
Protein	None
Bilirubin	None
Casts	None to few
Crystals	None
Bacteria	None or <1000/mL
Red blood cells	<3 cells/HPF
White blood cells	≤4 cells/HPF
Chloride	110-250 mEq/24 hr
Magnesium	7.3-12.2 mg/dL
Potassium	25-125 mEq/24 hr
Sodium	40-220 mEq/24 hr
Uric acid	250-750 mg/24 hr

HPF, High-powered field.

4. If the result is positive, a **blood** test is needed to confirm the results.

### H. Home test kits for HIV

1. In one at-home test kit, a drop of **blood** is placed on a test card with a special code number; the card is mailed to a laboratory for testing for HIV antibodies.
2. The individual receives the results by calling a special telephone number and entering the special code number; test results are then given.

### I. Nursing considerations

1. Maintain issues of confidentiality surrounding HIV and AIDS testing.
2. Follow prescribed state regulations and protocols related to reporting positive test results.

## XIII. URINE TESTS (Table 11-6)

## XIV. THERAPEUTIC SERUM MEDICATION LEVELS (Table 11-7)

**TABLE 11-7** Therapeutic Serum Medication Levels

Medication	Therapeutic Range
Acetaminophen (Tylenol)	10-20 mcg/mL
Amikacin (Amikin)	25-30 mcg/mL
Amitriptyline	120-150 ng/mL
Carbamazepine (Tegretol)	5-12 mcg/mL
Chloramphenicol (Chloromycetin)	10-20 mcg/mL
Desipramine (Norpramin)	150-300 ng/mL
Digoxin (Lanoxin)	0.5-2 ng/mL
Disopyramide (Norpace)	2-5 mcg/mL
Ethosuximide (Zarontin)	40-100 mcg/mL
Gentamicin	5-10 mcg/mL
Imipramine (Tofranil)	150-300 ng/mL
Lidocaine (Xylocaine)	1.5-5 mcg/mL
Lithium (Lithobid)	0.5-1.2 mEq/L
Magnesium sulfate	4-7 mg/dL
Phenobarbital (Luminal)	10-30 mcg/mL
Phenytoin (Dilantin)	10-20 mcg/mL
Propranolol (Inderal)	50-100 ng/mL
Salicylate	100-250 mcg/mL
Theophylline	10-20 mcg/mL
Tobramycin (Nebcin)	5-10 mcg/mL
Valproic acid (Depakene)	50-100 mcg/mL



### MORE QUESTIONS ON THE CD!

#### Practice Questions

- 63.** A client with atrial fibrillation who is receiving maintenance therapy of warfarin sodium (Coumadin) has a prothrombin time (PT) of 35 seconds. Based on the prothrombin time, the nurse anticipates which of the following prescriptions?
1. Adding a dose of heparin sodium
  2. Holding the next dose of warfarin
  3. Increasing the next dose of warfarin
  4. Administering the next dose of warfarin
- 64.** The nurse checks the laboratory result for a serum digoxin level that was prescribed for a client earlier in the day and notes that the result is 2.4 ng/mL. The nurse should take which immediate action?
1. Notify the physician.
  2. Check the client's last pulse rate.
  3. Record the normal value on the client's flow sheet.
  4. Administer the next dose of the medication as scheduled.
- 65.** A client has been admitted to the hospital for urinary tract infection and dehydration. The nurse determines that the client has received adequate volume replacement if the blood urea nitrogen level drops to:
1. 3 mg/dL
  2. 15 mg/dL
  3. 29 mg/dL
  4. 35 mg/dL
- 66.** A client arrives in the emergency room complaining of chest pain that began 4 hours ago. A troponin T blood specimen is obtained, and the results indicate a level of 0.6 ng/mL. The nurse determines that this result indicates:
1. A normal level
  2. A low value that indicates possible gastritis
  3. A level that indicates a myocardial infarction
  4. A level that indicates the presence of possible angina
- 67.** A client is receiving a continuous intravenous infusion of heparin sodium to treat deep vein thrombosis. The client's activated partial thromboplastin (aPTT) time is 65 seconds. The nurse anticipates that which action is needed?
1. Discontinuing the heparin infusion
  2. Increasing the rate of the heparin infusion
  3. Decreasing the rate of the heparin infusion
  4. Leaving the rate of the heparin infusion as is
- 68.** A client with a history of cardiac disease is due for a morning dose of furosemide (Lasix). Which serum potassium level, if noted in the client's laboratory report, should be reported before administering the dose of furosemide?
1. 3.2 mEq/L
  2. 3.8 mEq/L
  3. 4.2 mEq/L
  4. 4.8 mEq/L
- 69.** A client with a history of gastrointestinal bleeding has a platelet count of 300,000 cells/mm<sup>3</sup>. The nurse should take which action after seeing the laboratory results?