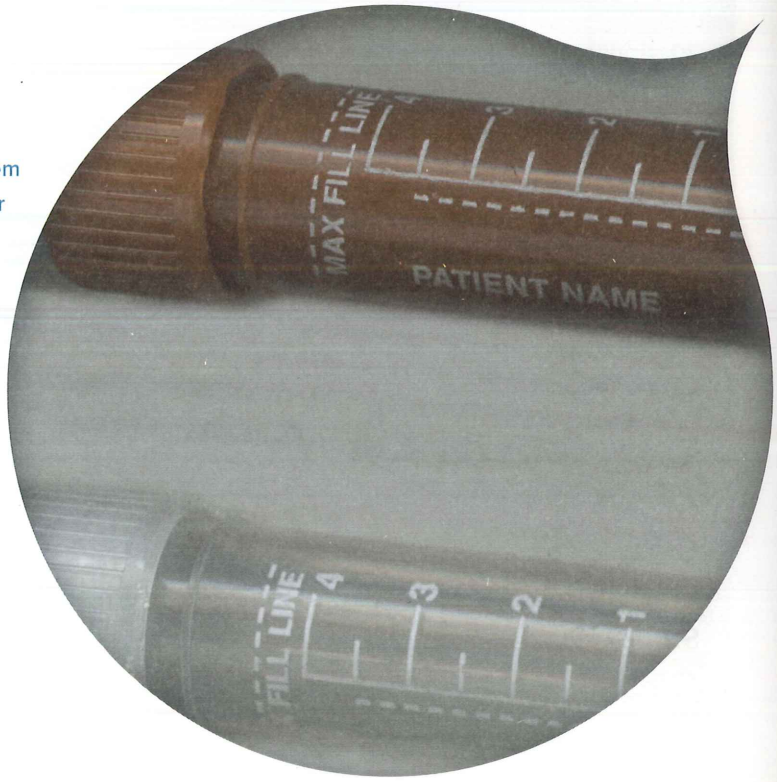
11 Blood Specimen Handling

essential terms

additive-to-blood ratio
aerosol
aliquoting
autoantibodies
centrifuging
chain of custody
cold agglutinins
delta check
glycolysis
icteric
light-sensitive
lipemia
pneumatic tube system
pre-examination error
real-time tracking
reference laboratory
STAT (ST)



Lillian Mundt

Learning Outcomes

11.1 Explain methods for transporting and processing blood specimens for routine and special testing and to reference laboratories.

11.2 Recognize the types of specimens that require special handling and the criteria for handling each specimen.

11.3 List the circumstances that would lead to re-collection or rejection of a patient sample.

Related NAACLS Competencies

4.4 Define the phlebotomist's role in collecting and/or transporting these specimens to the laboratory.

4.5 List the general criteria for suitability of a specimen for analysis, and reasons for specimen rejection or recollection.

5.5 Describe the substances that can interfere in clinical analysis of blood constituents and ways in which the phlebotomist can help to avoid these occurrences.

7.1 Demonstrate understanding of requisitioning, specimen transport, and specimen processing.

7.3 Instruct patients in the proper collection and preservation for non-blood specimens.

7.4 Explain methods for transporting and processing blood specimens for routine and special testing.

7.5 Explain methods for processing and transporting blood specimens for testing at reference laboratories.

7.6 Identify and report potential pre-analytical errors that may occur during specimen collection, labeling, transporting, and processing.

7.7 Describe and follow the criteria for specimens and test results that will be used as legal evidence, e.g., paternity testing, chain of custody, blood alcohol levels, etc.

9.9 Define and use medico legal terms and discuss policies and protocol designed to avoid medico legal problems.

Introduction

Once a specimen is collected, special care must be taken to maintain its quality. This chapter describes the ways in which specimens are transported to the testing laboratory, the handling of specimens requiring special conditions during transport, the processing of specimens using centrifugation, and the causes for specimen rejection.

11.1 Specimen Transport

The processes of venipuncture and dermal (capillary) puncture involve more than just the collection of a blood sample. The way in which blood specimens destined for testing are handled within the healthcare setting is of crucial importance to the phlebotomist, the laboratory personnel, and, of course, the patient. One minor mistake may result in a large error that could end up causing harm to the patient. Equally important is how the sample is transported and handled after the collection. All specimens must be transported to the laboratory in a timely manner.

Transporting Specimens Within the Facility

In some laboratories, the outpatient phlebotomy area is part of the laboratory, so transporting may simply require a walk to the next room. However, sometimes the phlebotomy area is in a different part of the building, so transportation becomes more important. Some medical facilities use **pneumatic tube systems** or other devices to expedite the process of transporting specimens to the laboratory. A pneumatic tube system moves tubes using a vacuum, just like the tube system at the bank drive-through window (see Figure 11-1). Other devices for transporting specimens include a dumbwaiter (small elevator), automated tracks, robotics, or a series of conveyor belts.

Figure 11-1 Pneumatic tube system.
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Each type of transport system may have specific effects on laboratory test results, so a laboratory considering the adoption of one of these methods should study the effects before selecting a transport method. For example, some pneumatic tube systems may agitate or disturb the specimen, resulting in hemolysis or other adverse effects. Automated systems may require facilities to provide a clearance for the installation of tracks or robotic sensors. Laboratories should validate all methods of specimen transport prior to establishing a policy that allows for alternate ways of delivering specimens to the laboratory.

There are many reasons for rapid delivery of specimens. Some tests are ordered as **STAT (ST)** (immediately) and must be performed immediately on arrival at the laboratory. Results for tests ordered STAT are usually expected within 1 hour after they are ordered. Refer to the

Figure 11-2 Courier specimen pickup lockbox.
Sandra Mesrine/McGraw-Hill Education

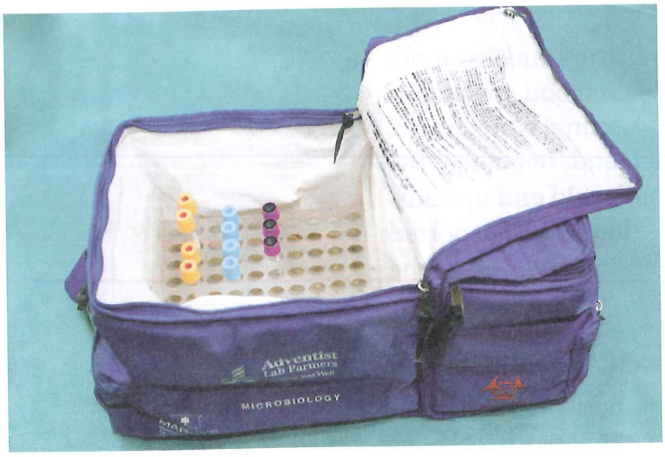

Figure 11-3 Courier transport container.
Sandra Mesrine/McGraw-Hill Education

SOP (standard operating procedure) at your facility. Some specimens require centrifugation and separation of plasma or serum from cells within a specified amount of time. Ideally, the specimen should be taken to the laboratory within 45 minutes and centrifuged within 1 hour. CSLI standards recommend a limit of 2 hours between collection and separation of serum or plasma by centrifugation. Operation of the centrifuge is discussed later in this chapter. If you are unsure of specimen requirements, look them up in the procedure manual. If the blood is not taken to the laboratory within the specified time limit, the test results will be inaccurate.

Transporting Specimens From Outside the Facility

Outpatient facilities present a different challenge with regard to transportation of laboratory specimens. Usually, a courier service transports the specimens from the collection facility to the hospital's laboratory. Specimens may need to be processed at the outpatient facility before being transported to the reference laboratory. You may be required to follow special handling procedures for the specimens drawn. Specimens for pickup from outpatient facilities are often placed in courier pickup lockboxes just inside or outside the facility (see Figure 11-2). Policies should be in place concerning the length of time these specimens stay in these boxes, as well as how to protect them from extreme temperatures. Couriers should follow a predetermined pickup schedule and ensure specimen integrity by maintaining specific specimen requirements, which include the use of proper transport containers (see Figure 11-3).

Transporting Specimens to Other Facilities

Some tests that physicians order must be sent to a **reference laboratory** or another facility because the hospital's laboratory does not perform the tests. Reference laboratories usually offer a larger variety of laboratory tests than the average community hospital laboratory. Depending on the location of the reference laboratory, it may provide its own courier service, or specimens may have to be shipped to the laboratory. Specimens sent in the mail or through express delivery services, such as FedEx, must comply with local, state, and federal laws governing special packaging and biohazard identification. In general, packages containing clinical specimens must include the following:

- A watertight primary container
- An original specimen tube or a plastic screw-cap transfer tube
- Absorbent material
- A watertight secondary container, such as a ziplocked bag, plastic canister, or Styrofoam box
- Sturdy outer packaging, such as a fiberboard box or mailing tube, wooden box, or rigid plastic container (see Figure 11-4)

The primary container holding the specimen should be labeled the same as the original specimen. This container is then wrapped with the absorbent material and placed in a secondary container. Any accompanying paperwork is affixed to or enclosed in the secondary container and must include specimen identification along with appropriate biohazard labels attached. A coolant (ice packs or dry ice) may be required in the secondary container for refrigerated or frozen specimens. The secondary container is then placed in the outer package for shipping, which must display appropriate biohazard warning labels in addition to the sender and recipient addresses. Carrier documentation is affixed to the shipping container and must include the weight of dry ice, if present. Figure 11-5 shows a cross-sectional view of a specimen properly packaged for shipping. Facilities must package and ship specimens according to the regulations set by the agency governing the type of specimen that is being shipped. Table 11-1 lists agencies that regulate the transportation of medical specimens.

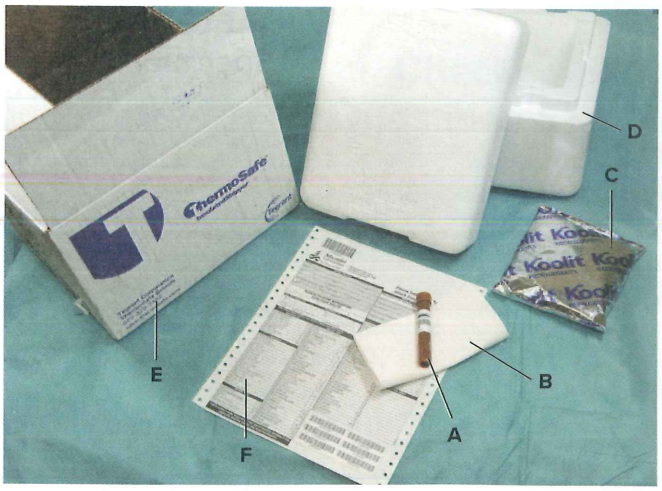

Figure 11-4 The requirements for specimen packaging include (A) the specimen or its aliquot in a properly labeled primary leakproof container, (B) absorbent material, (C) a coolant, (D) secondary container, (E) shipping container, and (F) paperwork including patient, specimen, and test information.
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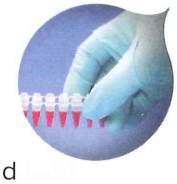
Protecting Personnel



Safety & Infection Control

Protecting personnel is important when transporting specimens. Tubes containing specimens are usually placed in biohazard bags for safe transport. If a specimen is dropped and the tube breaks, the blood or body fluid will stay contained inside the bag. If specimens are sent by pneumatic tube or automated systems, they, too, should first be placed inside biohazard bags. When opening the pneumatic tube to receive a specimen in the laboratory, phlebotomists should wear personal protective equipment (PPE), including gloves, a lab coat, and face protection. The specimen container may have broken in transit and the specimen may have spilled into the carrier tube. If this is the case, you must follow your facility's policies and procedures for proper decontamination of the pneumatic carrier tube.

Tracking Specimen Transit

Documentation of specimen collection and transport is essential for proper record keeping. If test results are questionable, the collection and transport information can provide valuable clues as to the cause of invalid results. For

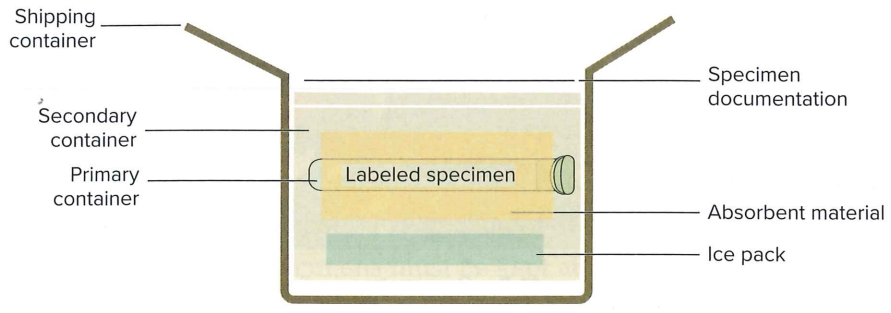


Figure 11-5 Cross-sectional diagram of specimen shipping packaging.

TABLE 11-1 Agencies That Regulate the Transport of Medical Specimens

Agency	Acronym	Website
Centers for Disease Control and Prevention	CDC	www.cdc.gov
Department of Transportation	DOT	www.transportation.gov
Federal Aviation Administration	FAA	www.faa.gov
Food and Drug Administration	FDA	www.fda.gov
International Air Transport Association	IATA	www.iata.org
International Civil Aviation Organization	ICAO	www.icao.int
Occupational Safety and Health Administration	OSHA	www.osha.gov
Transportation Safety Administration	TSA	www.tsa.gov

example, if a specimen is hemolyzed, knowing how long it sat in a courier pickup box or courier vehicle may help explain the cause of the hemolysis.

In addition to recording collection information on the specimen label, phlebotomists must enter specific data into the patient's electronic health record (EHR) using the laboratory information system (LIS), including the date and time of collection, the phlebotomist's identification code, and any comments that might aid in specimen analysis, such as "collected from below IV site of right arm" (see Figure 11-6). This information is readily accessible and provides a specimen tracking system. Couriers also enter information into the LIS regarding the pickup and drop-off of specimens.

Some facilities require phlebotomists and couriers to scan bar codes on specimens with a device that communicates with the LIS to provide **real-time tracking** (see Figure 11-7). Real-time tracking of laboratory specimens is similar to the system used by the U.S. Postal Service and United Parcel Service to track packages. Real-time tracking allows laboratory personnel to estimate when they will have the specimen. This is useful so that laboratory personnel can inform the physician or nurse of the approximate time the test results will be ready.

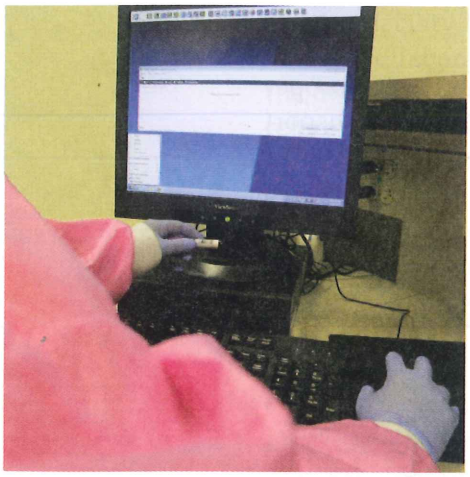


Figure 11-6 Phlebotomist entering collection data into the LIS.
Lillian Mundt

Figure 11-7 Courier bar-coding specimen delivery confirmation data.
Sandra Mesrine/McGraw-Hill Education

Checkpoint Questions 11.1

1. According to CSLI standards, what is the maximum allowable time between obtaining a blood specimen and centrifugation?
2. List two reasons for tracking specimens.
3. Explain why leaving a specimen in an outdoor courier box may not be the best practice for maintaining a quality laboratory specimen.

11.2 Special Specimen Handling

The way a specimen is collected, handled, and transported are essential to whether a specimen is accepted and the results are accurate. Special handling applies to specimens that are to be kept warm, cool, or protected from light. Special handling also includes processes such as special identification for legal specimens as well as centrifugation and separation prior to specimen delivery. Table 11-2 presents a list of common laboratory tests that require special handling.

Temperature-Sensitive Specimens

Some specimens for laboratory testing must be maintained within a specific temperature range, either warm or cool. They are placed in the appropriate environment immediately upon collection and are kept there until delivery to the laboratory.

Specimens Requiring Warmth During Transit

Testing for **cold agglutinins,** or antibodies that react at cooler temperatures, is done for patients suspected of having conditions such as atypical pneumonia. People with atypical pneumonia are infected with *Mycoplasma pneumoniae* and can produce **autoantibodies** (antibodies against oneself). These antibodies, also known as immunoglobulins, attack the patient's own body as if the body were foreign.

Cold agglutinins react with red blood cells at temperatures lower than body temperature, which has a normal range of 97.6°F to 99.6°F (36.5°C to 37.6°C). The cold temperature reaction is the principle of the laboratory test for atypical pneumonia. After a blood specimen is drawn, it begins to cool, or drop below body temperature. At temperatures lower than body temperature, cold agglutinins in the plasma attach to red blood cells, causing clumping. Collection tubes for cold agglutinins may be red-topped tubes that contain no additives or lavender-topped EDTA tubes, depending on specific laboratory requirements. In addition, the following requirements must be followed when working with collection tubes for cold agglutinins:

- The tubes must be prewarmed by placing them in a container of water that is 98.6°F (37°C). The tubes can also be placed in another warming device such as a heel warmer before collection and kept warm throughout the process.
- The tubes must be delivered directly to the laboratory section responsible for performing this test and placed in an incubator or water bath in the laboratory, set at 98.6°F (37°C) (see Figure 11-8). Care should be taken to keep the specimen at 98.6°F (37°C). Failure to keep the specimen warm will result in erroneous laboratory results.
- Cold agglutinin test specimens must be kept at body temperature until the serum or plasma can be separated from the cells, which must be done within 1 hour.

TABLE 11-2 Common Laboratory Tests that Require Special Handling

Special Handling	Laboratory Tests
Place in ice-water mixture.*	Adrenocorticotropic hormone (ACTH) Ammonia Catecholamines Gastrin Lactic acid Parathyroid hormone (PTH) pH/blood gas
Protect from light.**	Beta-carotene Bilirubin, total or direct Porphyrins Thioridazine (Mellaril®) Vitamin A Vitamin B_6 Vitamin B_{12}
Deliver to lab within 1 hour. Separate, and freeze serum after clotting.	Acid phosphatase Prostate-specific antigen (PSA) Prostatic acid phosphatase
Use antiseptic other than alcohol to cleanse venipuncture site.	Blood alcohol
Incubate at 98.6°F (37°C) until clotted.	Clot retraction Cold agglutinins (warm tube, incubate until clotted; separate immediately after clotting)
Separate, freeze serum after clotting.	Complement, C4
Let clot in refrigerator. Separate immediately and freeze serum.	Complement, total (50) Complement, total (100)
Label peak or trough.	Gentamicin Tobramycin Vancomycin
Label tubes with time interval.	Glucose tolerance
Maintain at room temperature; do not refrigerate or freeze.	Human leukocyte antigen (HLA-B27)

*Place in ice-water mixture = cover label with plastic and place tube in a cup with a mixture of ice and water.
**Protect from light = protect by wrapping the tubes in aluminum foil or using plastic amber tubes.

- Routine venipuncture procedures are followed, with the noted addition of the warmed collection tube.

Specimens Requiring Chilling During Transit

Unlike testing for cold agglutinins and clot retraction, some specimens must be chilled immediately after collection. Chilling specimens slows down the metabolic process, keeping analyte levels as close as possible to those found in the bloodstream. Tests such as arterial blood gases, ammonia, and lactic acid require chilling. Blood collected for these tests is placed in a container with a slurry of crushed ice and water, as shown in Figure 11-9A. To protect the label, the tube is first placed in a specimen transport bag that is zipped

shut. Alternately, the tube can be placed in the outer pocket of a two-compartment specimen bag with an ice slurry (Figure 11-9B) or cold pack (Figure 11-9C) placed in the zippered compartment. Be aware, however, that the specimen must not be allowed to freeze, as this will cause hemolysis. Ensure that your slurry of ice and water includes enough water so that the specimen is evenly cooled. Specimens may even require collection in a prechilled evacuated tube. Refer to the policy at your place of employment to determine what special handling must be given each blood test you will be collecting. Use the competency checklist *Specimen Handling: Temperature-Sensitive Specimens* at the end of this chapter to review and practice the procedure.

Figure 11-8 Specimens that need to be kept warm can be placed into a heating block set at the correct temperature.
Sandra Mesrine/McGraw-Hill Education

Light-Sensitive Specimens

Some substances are **light-sensitive,** meaning that they break down when exposed to light. Specimens collected to test for these substances must be covered in foil or placed in a special container to protect them from light (see Figure 11-10). Microcollection containers, as shown in Figure 11-11, are available in amber plastic, which protects specimens from light. The amber plastic container protects the specimen in much the same way as tinted glasses protect eyes from sunlight. Substances such as bilirubin and carotene require protection from light because light (especially sunlight) can alter their chemical composition. Use the competency checklist *Specimen Handling: Light-Sensitive Specimens* at the end of this chapter to review and practice the procedure.

Life Span Considerations

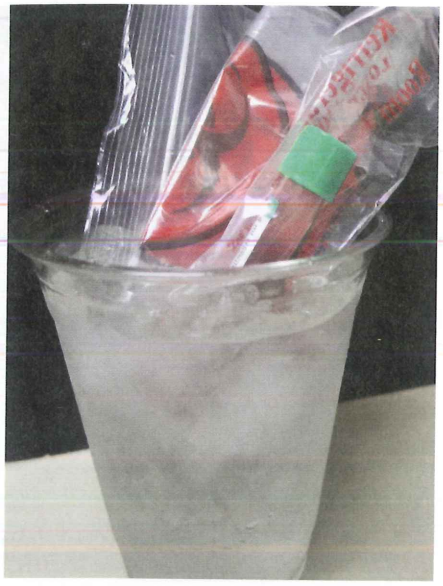
Neonatal Bilirubin

Bilirubin levels are commonly performed on newborn infants. Infants normally have an increased level of red blood cells at birth. As the extra red blood cells break down, bilirubin forms and may be deposited in tissues. If too much is in the infant's body tissue, it must be removed by placing the infant under ultraviolet light. It is very important to turn off the ultraviolet light when collecting blood from an infant under this light because leaving the light on will destroy some of the bilirubin in the specimen as you are collecting it. This may falsely lower the bilirubin result when the blood is tested. Be sure to turn the light back on after you finish collecting the specimen and safely remove it from under the lamp.

Blood Alcohol, Forensic Testing, and Toxicology Specimens

Certain phlebotomy procedures, such as blood alcohol testing, forensic testing, and toxicology, require extra considerations regarding the patient, collection, and specimen handling. Test results obtained for these procedures may be used in a court of law.

Specimens of a legal matter require special handling. Blood and other specimens are often collected from a victim, a suspect, or another person—dead or alive—involved in a legal matter. These specimens must be correctly identified



A

B C

Figure 11-9 Special handling procedures may involve placing the tube in a cup of ice-water mixture or in a double-compartment specimen transport bag with ice or cold pack in a separate compartment.
A–C: Lillian Mundt

Figure 11-10 Specimens for measurement of substances that are affected by light are usually wrapped in foil.
Total Care Programming, Inc.

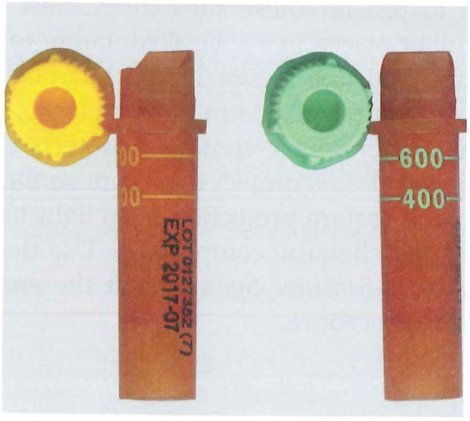


Figure 11-11 Amber-colored microcollection containers.
Lillian Mundt

and under the uninterrupted control of authorized personnel to ensure their validity. Accurately identifying a specimen and making sure it has not been altered or replaced is called establishing a **chain of custody.** This procedure is required for medicolegal specimens for which test results are needed in court cases, such as evidence of rape or drug tests for illicit drug use. If the chain of custody between the victim and/or suspect and the specimen cannot be proved to have remained unbroken, the specimen and any tests performed on this specimen will be considered invalid.

The first link in the chain of custody is collecting the specimen. During this process, make sure to collect the specimen from the correct patient and guard against tampering. The chain-of-custody form (see Figure 11-12) must be completed correctly and the patient may be required to sign or initial the form. The chain-of-custody procedure dictates that each person who handles the specimen must sign and date the legal document. The document indicates the name of the person from whom the specimen was received, the person to whom the specimen was given, and the length of time each person had the specimen. Multiple copies of the form are used as a safeguard system. One copy, usually the original, accompanies the specimen in a sealed envelope.

Morris A. Turner, MD
C.L.I.A #21.1862

266 Line Road
Montelair, Delaware 00956
800-555-1567

MedLAB

CHAIN OF CUSTODY FORM

SPECIMEN I.D.NO:

STEP 1—TO BE COMPLETED BY COLLECTOR OR EMPLOYER REPRESENTATIVE.

Employer Name, Address, and I.D. No.: _____ OR Medical Review Officer Name and Address: _____

Donor Social Security No. or Employee I.D. No.: _____

Donor I.D. verified: ☐ Photo I.D. ☐ Employer Representative _____ Signature

Reason for test: (check one) ☐ Preemployment ☐ Random ☐ Postaccident ☐ Periodic ☐ Reasonable suspicion/cause ☐ Return to duty ☐ Other (specify)

Test(s) to be performed: _____ Total tests ordered: ☐

Type of specimen obtained: ☐ Urine ☐ Blood ☐ Semen ☐ Other (specify)

Submit only one specimen with each requisition.

STEP 2—TO BE COMPLETED BY COLLECTOR.

For urine specimens, read temperature within 4 minutes of collection.
Check here if specimen temperature is within range. ☐ Yes, 90°–100°F/32°–38°C
Or record actual temperature here: _____

STEP 3—TO BE COMPLETED BY COLLECTOR.

Collection site _____ Address _____
City _____ State _____ Zip _____ Phone _____
Collection date: _____ Time: _____ ☐ a.m. ☐ p.m.

I certify that the specimen identified on this form is the specimen presented to me by the donor identified in step 1 above, and that it was collected, labeled, and sealed in the donor's presence.

Collector's name: _____ Signature of collector: _____

STEP 4—TO BE INITIATED BY DONOR AND COMPLETED AS NECESSARY THEREAFTER.

Purpose of change	Released by Signature	Received by Signature	Date
A. Provide specimen for testing			
B. Shipment to Laboratory			
C.			

Comments:

STEP 5—TO BE COMPLETED BY THE LABORATORY.

Specimen package seal(s) intact when received in lab? ☐ Yes ☐ No If no, explain.
Laboratory receiver's initials _____

Copy 1 - Original - Must accompany specimen to laboratory.

Figure 11-12 Each person handling a legal specimen must complete and sign the chain-of-custody form.

Another copy is attached to the outside of the envelope, so that each person who handles the specimen can initial the form. A third copy is usually retained in the patient's file.

In addition, the specimen must be kept in a locked container and/or the tube must be sealed with a tamperproof label or wax at all times to prevent unauthorized personnel from tampering with the sample. The chain of custody

accounts for the specimen from the time of collection to the final disposition of the specimen and guarantees the integrity of the specimen in a court of law. These general procedures help maintain an intact chain of custody. Always refer to the procedure at your facility to make sure you are meeting all relevant requirements.

Law & Ethics

Legal Blood Alcohol Specimens

It is critical for the phlebotomist to understand that the patient has the right to refuse to give a blood alcohol specimen unless that right has been legally removed by an appropriate legal action. If the test is being required due to an accident or possible litigation, there must be a legal document, signed by the proper authorities, authorizing the draw. It is up to the phlebotomist to determine if these legalities have been completed before the draw. If not, the phlebotomist can be sued for assault and battery. If the specimen is being ordered for possible litigation, a chain-of-custody form must also be filled out and the top of the tube must be sealed with a tamperproof label or wax.

Blood Alcohol Testing

The police may request a blood alcohol level because of a charge of driving under the influence (DUI). Before the test can be performed, the patient must consent to having the test done, and the patient can refuse the test. If the phlebotomist attempts to collect a specimen for the test without written consent from the patient or a court order, the phlebotomist can be found guilty of assault and battery and the test is not admissible in court.

An employer may request a blood alcohol level because an employee appears to be intoxicated. Care must be taken when collecting a blood alcohol specimen because these specimens are often needed for legal reasons. The chain-of-custody procedure must be followed. Most tests require a glass potassium oxalate tube (gray topped) filled to the top. Never remove the stopper of the tube when collecting. Typically a commercially prepared kit is used.

The venipuncture collection process is the same with the exception of cleansing the site. Although the alcohol in an alcohol prep pad is different from the alcohol used for human consumption, an alcohol prep pad must *not* be used because its use will cause the legal system to question the blood alcohol result. Thus, the venipuncture site must be cleaned with a *disinfectant* (a solution containing an agent intended to kill microorganisms) other than alcohol, such as green surgical soap or hydrogen peroxide. Do not use iodine swabs because they also contain alcohol.

Law & Ethics

Following Protocols

The phlebotomist's job also includes ensuring that all collection protocols are followed during a procedure. If you collect a blood alcohol level, you must take extra care that the site is cleaned with a nonalcohol cleanser. A contaminated or false-positive result could cause the police officer to lose the court case or a person to lose their job or even go to jail. A phlebotomist involved in collecting a blood alcohol specimen for legal reasons can be summoned to appear in court, so the phlebotomist needs to be especially diligent in following all established collection protocols.

Forensic Testing

Forensic specimens usually involve testing specimens for legal cases. Forensic and legal specimens must follow the chain-of-custody procedure. General guidelines for forensic testing are shown in Learn How 11-1. The types of specimens listed in Table 11-3 are commonly obtained and used for forensic purposes. The primary aim of forensic testing is to provide evidence that may help prove or disprove a link between an individual and objects, places, or other individuals.

Learn How 11-1

Forensic Testing Guidelines

1. Avoid contamination by wearing gloves at all times.
2. Collect the specimen as soon as possible.
3. Ensure that the specimen is packed, stored, and transported correctly. In general, fluids are refrigerated and other specimens are kept dry and at room temperature.
4. Label each specimen with the patient's name and date of birth, the name of the person collecting the specimen, the type of specimen, and the date and time of the collection.
5. Make sure the specimen is packed securely and is tamperproof. Only authorized people should touch the specimen.
6. Record all handling of the specimen, most commonly on a chain-of-custody form.

Check for guidelines specific to your place of employment. In some cases, you will use a special evidence kit (see Figure 11-13). Know the specific procedure and perform it only if you have had the proper training to collect forensic specimens.

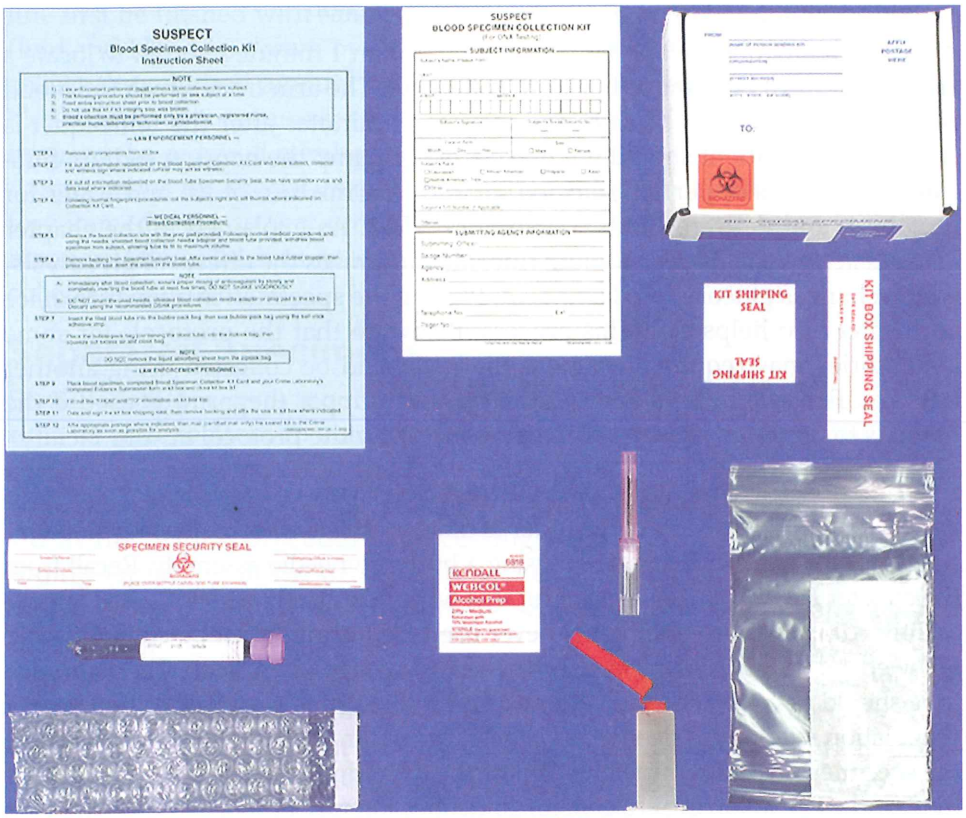


Figure 11-13 A forensic specimen kit such as this one may be used at your facility.
Tri-Tech Forensics, Inc.

TABLE 11-3 Samples Collected for Forensic Purposes

- Blood
- Bones
- Hair
- Nails
- Saliva
- Skin
- Sperm
- Sweat
- Teeth
- Vaginal
- Mud
- Vegetation

Toxicology Specimens

Toxicology is the scientific study of poisons, drugs, and medications. Toxicologists study the detection of poisons, the action of poisons on the human body, and the treatment of the medical conditions that poisons can cause. Toxicology may also include testing for trace elements, such as aluminum, lead, mercury, and zinc. Another important function of toxicology is to determine the peak and trough levels of patient medications, as discussed in the chapter *Patient and Specimen Requirements*.

Some toxicology specimens are performed in the chemistry section of the laboratory, whereas others require testing at a reference laboratory. For toxicology specimens, it is critical to follow your laboratory's protocol for collection, type of specimen, and equipment usage. Oil or bacteria from hands, glass, or plastic materials will contaminate or even react with some of the analytes.

Special Handling During Venipuncture

For some laboratory specimens, special handling is part of the venipuncture procedure. Examples of special handling during blood collection include

- not using alcohol (explained previously)
- not using a tourniquet
- collecting blood for special coagulation tests

Lactic Acid Blood Collection Procedure

To assess levels of lactic acid in the blood, some facilities require that venipuncture be performed *without* a tourniquet. Lactic acid forms in the muscles during carbohydrate metabolism and its blood level can be affected by

- exercise
- vigorous hand pumping prior to blood collection
- application of a tourniquet during blood collection

A tourniquet may be applied for no longer than 1 minute in order to locate a vein, but it must be removed prior to collection. The arm from which the blood is to be collected must be at rest for at least 2 minutes after the tourniquet is removed. The patient should not make a fist or pump the hand. A sodium fluoride tube (gray stopper) is collected, placed in a mixture of ice and water for transport, and delivered to the laboratory STAT. As explained in the chapter *Blood Collection Equipment*, sodium fluoride minimizes the effects of **glycolysis,** which changes glucose into lactic acid. Placing the specimen in a mixture of ice and water also helps slow this process. Be aware that the protocols for some laboratories may require specimens for lactic acid be collected using another additive. For example, in some cases a green stopper (heparin) is used if the blood is to be tested right away. As always, follow the protocol at your facility.

Specimens for Special Coagulation Studies

As you have already learned, the order of draw is critical when collecting blood for coagulation tests, especially when using a butterfly needle assembly. Recall from the chapter *Blood Collection Equipment* that when a butterfly needle is used, a nonadditive discard tube—one that is never used for testing—must be collected first, followed by a light-blue-topped tube used for coagulation tests. The light-blue tube should never be collected after any tube containing additives. When special coagulation studies are needed, a detailed procedure must be followed to collect the specimen. Phlebotomists must follow the procedure used by the facility where they work. The following are general guidelines for special coagulation collection:

- In addition to following a strict order of draw, special coagulation venipunctures must be performed using a large-bore needle (nothing smaller than a 21 gauge).

TABLE 11-4 Coagulation Studies Often Requiring Special Handling

Coagulation Study	Specific Tests	Special Handling
Coagulation factor assays	Factors I, II, V, VII, VIII, IX, X, XI, XII, XIII, von Willebrand Factor	• May require discard tube • Centrifugation, separation, shipped frozen to reference lab
Coagulation inhibitor assays	Anti-thrombin III Antiphospholipids Lupus inhibitor Proteins S and C	• May require discard tube • Centrifugation, separation, shipped frozen to reference lab
Platelet function studies	Platelet antibodies Platelet inhibition Platelet function assay (PFA), platelet response (aspirin and/or Plavix®)	• May require discard tube • Centrifugation, separation, shipped frozen to reference lab • Requires discard tube • Immediate delivery to laboratory

- The procedure must be performed quickly to minimize the amount of time the tourniquet is applied.
- Each tube collected must be gently inverted the required number of times while the next tube is filling.

Sometimes phlebotomists assist nurses in collecting blood for coagulation studies through a venous access device. A phlebotomist may be asked to provide the needed equipment at the appropriate time in the procedure, transfer the specimen to evacuated tubes, and ensure adequate mixing. Blood collection from the line attached to the venous access device requires that the line first be flushed with saline and then that at least 10–20 milliliters (mL) of fluid and blood be drawn by syringe and discarded. A new syringe is used to collect the required amount of blood, which is immediately transferred into blue-stoppered tubes using a syringe transfer device. The tubes are then gently inverted the required number of times.

Specimens for special coagulation studies must be delivered to the laboratory immediately, so that proper processing and testing can occur in a timely manner. Table 11-4 lists special coagulation studies that may require special collection procedures.

Separated Specimens

Some laboratory tests require that specimens be separated as soon as possible after collection. In some facilities, phlebotomists are expected to process these specimens. Specimen processing may be a separate section of a large laboratory, and for the phlebotomist, this presents an opportunity to aid in the testing procedure. Processing patient samples involves **centrifuging** (spinning down or separating the cells from the liquid portion of the blood) and **aliquoting** (dividing or separating specimens into separate containers).

Whether a laboratory requires serum or plasma depends on the method they are using for testing, and not all laboratories use the same methods. Refer to the requirements of your laboratory when selecting an appropriate collection container and processing method. Remember that serum is obtained from tubes that do not contain an anticoagulant, such as red-topped and gold-topped tubes. Plasma is obtained from tubes contain an anticoagulant, such as light-blue-topped, lavender-topped, and green-topped tubes.

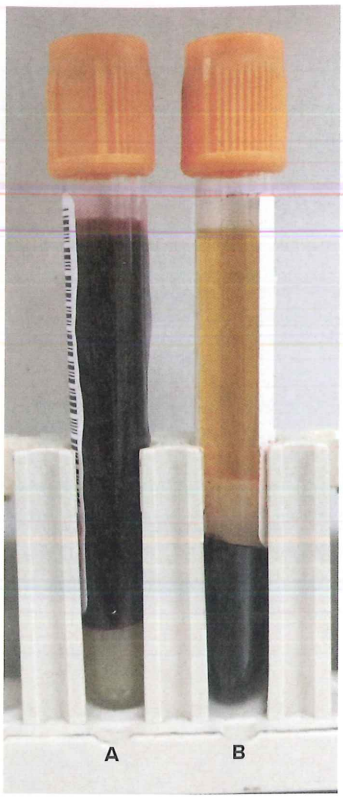


Figure 11-14 Serum separator tubes (A) uncentrifuged and (B) after centrifugation. Upon centrifugation, the separator gel forms a barrier between the blood cells (on the bottom) and the serum (on the top).
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For most laboratory tests that require serum or plasma, it is recommended that specimens be separated within 2 hours of collection. If specimens are not centrifuged or aliquoted within 2 hours, the laboratory test results may be altered. Potassium and glucose blood tests are most affected. If blood cells are left in contact with the serum or plasma, glucose can be decreased and potassium can significantly increase. Blood cells use glucose to keep alive and nourished, whereas potassium can slowly leak out of red blood cells.

Using the Centrifuge

Centrifuges come in many different styles: refrigerated, floor models, and tabletop models. The speed of rotation (revolutions per minute, or rpm) and the radius of the rotor head determine the relative centrifugal force (RCF) of a centrifuge. The relative centrifugal force is expressed as gravity (g). Centrifugal force used in a centrifuge is similar to that used by the spin cycle of a clothes washing machine. Centrifuges typically have dials for speed of rotation and time.

Laboratory centrifuges are designed to spin blood specimens, separating the cells from the liquid portion. Cells are pushed to the bottom while the liquids remain on top. If a gel separator is used, the gel will migrate to the middle and form a barrier between the cell and liquid layers. Nonadditive tubes and serum separator tubes (SSTs) must be completely clotted prior to centrifugation. Figure 11-14 shows specimens before and after centrifugation.

Most laboratory specimens are centrifuged at 1000 to 3000 rpm for 15 minutes. Times and speeds depend on the specimen requirement and the manufacturer's recommendation. Tubes of various sizes can be spun in the same centrifuge at the same time. Be sure to place tubes of equal size and volume directly across from each other (see Figure 11-15). Also, make sure that the levels of sample are the same, so that the centrifuge will be balanced. If you do not have an even number of blood tubes to spin, you can balance the centrifuge with a similar tube filled with water or saline. An unbalanced centrifuge is similar to a washing machine that is heavier on one side than the other.

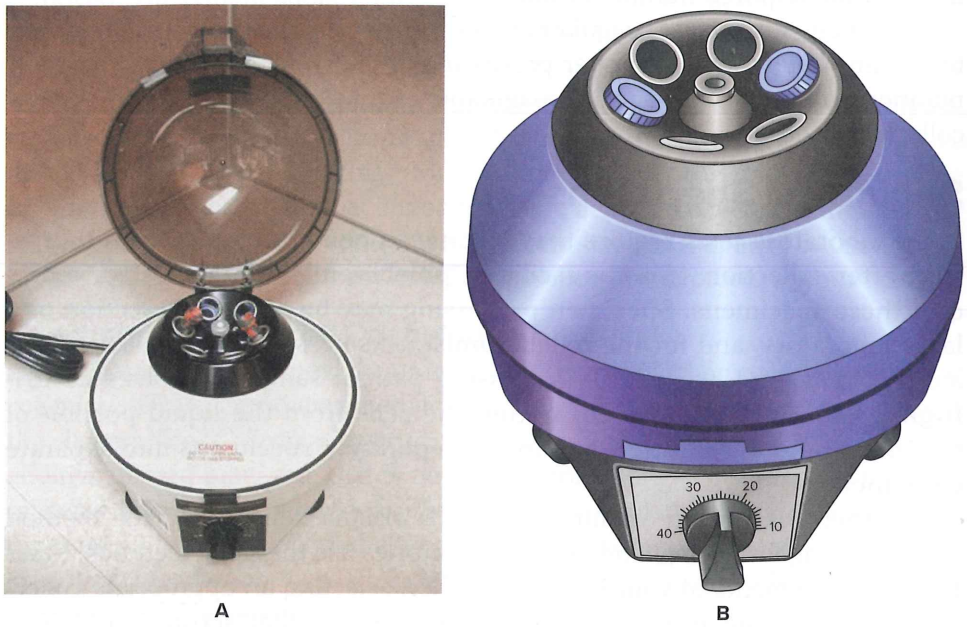

Figure 11-15 (A) Common style countertop centrifuge. (B) Centrifuge showing tube placement.
Total Care Programming, Inc.

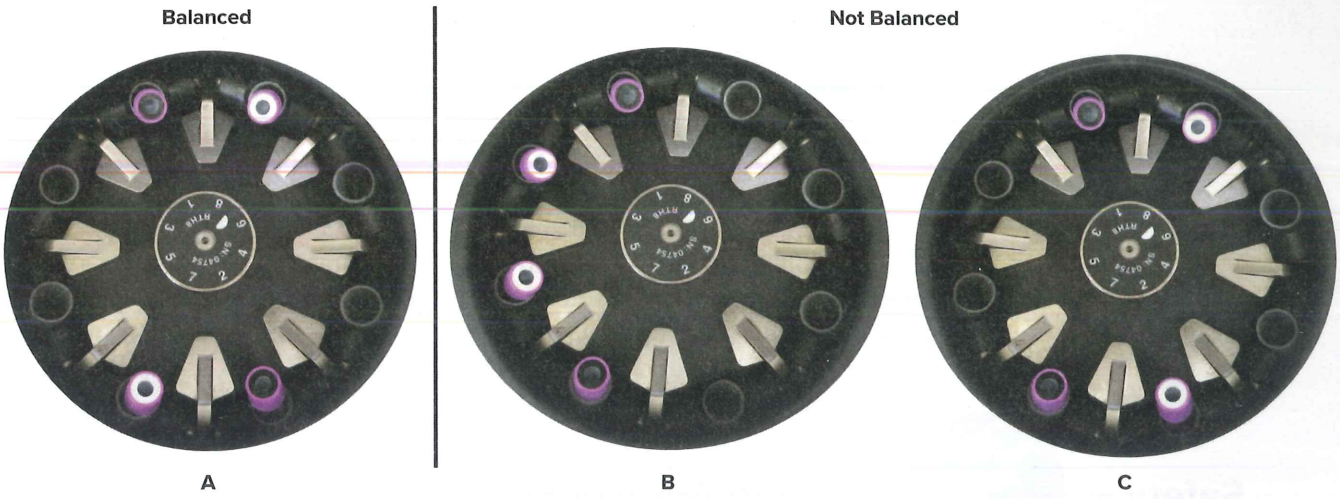

Figure 11-16 Small centrifuges with a few specimens. (A) Tubes of equal size and volume are placed directly across from each other. (B) Tubes placed all to one side and (C) tubes of unequal size and volume placed across from each other will cause damage to the centrifuge and may result in harm to the operator. Although image (C) appears balanced, remember that Bio-One tubes with dark rings are standard volume tubes while those with white rings draw less volume.
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It will jump around, will make unusual noises, and may damage the specimens or injure the phlebotomist. Figure 11-16 compares balanced and unbalanced tube placement within a centrifuge. Centrifuges are available that can handle several specimens at one time. Specimens in these centrifuges must also be distributed evenly according to volume and weight (see Figure 11-17). Tubes placed in the centrifuge should have their caps in place. If the cap is missing, the tube should be covered before running the centrifuge.

After closing the lid securely, turn on the centrifuge and set the timer for the time designated in your procedure manual (usually 10–15 minutes). Wait until the centrifuge has reached its running speed before leaving the area. If the centrifuge is loaded with samples that are not balanced, the centrifuge will vibrate and make noise. If you are nearby, you can turn off the centrifuge before the unbalanced specimens are broken. The centrifuge must be

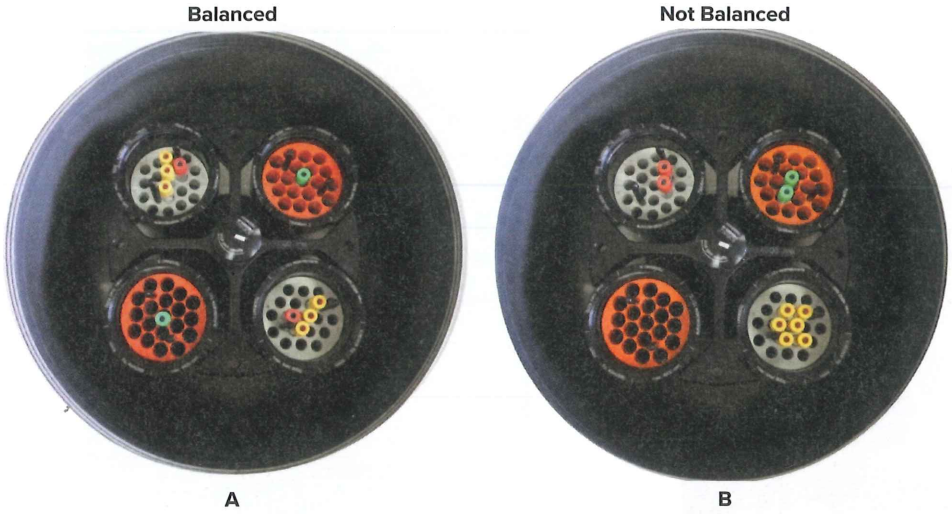

Figure 11-17 Large centrifuges for multiple specimens. (A) Tubes of equal size and volume are placed directly across from each other. (B) Tubes grouped by type result in unequal placement and will cause damage to the centrifuge. They also may result in harm to the operator.
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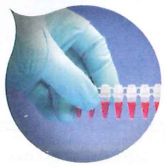
calibrated regularly to ensure proper centrifugation (discussed further in the chapter *Waived Testing*).

Improper use of a centrifuge can be dangerous to the user and can ruin laboratory specimens. If a tube is broken, the cup containing the broken tube must be completely emptied into a sharps container and disinfected.

Never open a centrifuge lid until the rotor has come to a complete stop. There might be a glass tube that shattered during the centrifuge process. If you open the lid before it stops, you run the risk of being injured by flying glass or debris. At a minimum, eye protection and gloves should be worn when opening the centrifuge and handling specimens. Use the competency checklist *Centrifuge Operation* at the end of this chapter to review and practice the procedure.

Safety & Infection Control



Avoiding Aerosol Exposure

The prevention of **aerosols** (mists that travel in the air) escaping when stoppers are removed or in uncovered centrifuged tubes is a major concern of laboratory personnel. Aerosols are similar to the droplets of moisture produced by a sneeze, but they are smaller and may not be easily detected. Aerosols can contain viruses and can endanger a person if inhaled. Shields (see Figure 11-18) are available for use when opening centrifuges or tubes; they act as a barrier between the person and the aerosol. Always follow the manufacturer's recommendations and your facility's policies when opening containers that may produce aerosols.

Aliquoting Specimens

As discussed previously, aliquoting is the process of transferring a portion of a specimen into one or more containers. Careful attention to detail is imperative when aliquoting patient specimens. Mixing up patient samples is one of the greatest concerns of all laboratory workers. Before you begin to aliquot a sample, make sure the transfer tube is properly labeled by comparing it to the label on the specimen tube that was used for collection. When opening a tube with a rubber stopper use a pad with absorbent backing to contain and prevent aerosols. A pipet (a graduated tube with a suction bulb) is used to transfer the serum or plasma to the transfer tube (see Figure 11-19). Be sure

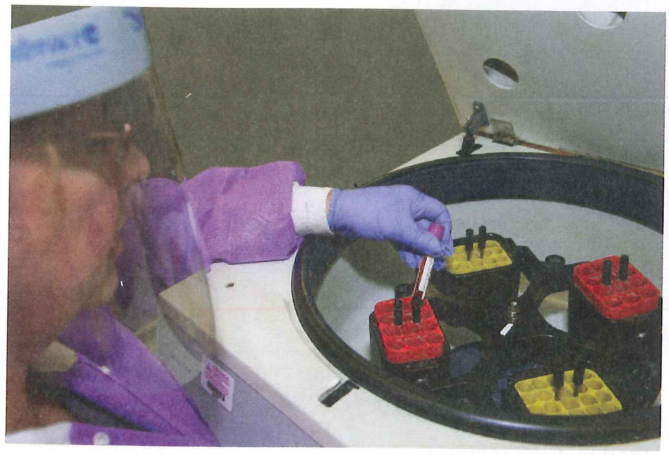


Figure 11-18 Phlebotomist using a face shield while opening a centrifuge.
Sandra Mesrine/McGraw-Hill Education

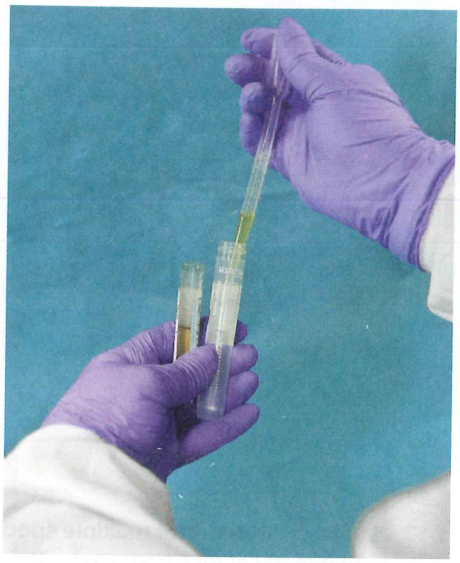


Figure 11-19 Phlebotomist transferring a specimen from a collection tube to a transfer tube.
Sandra Mesrine/McGraw-Hill Education

to check the specimen requirements before selecting an appropriate transfer tube. Some transfer tubes are clear plastic, whereas others are amber-colored for light-sensitive specimens. The person processing the specimen must also ensure that aliquoted specimens are stored properly prior to and during delivery to the laboratory section or reference laboratory.

Checkpoint Questions 11.2

1. You need to centrifuge three tubes of blood. Two of the tubes are adult-size and the other is pediatric-size. Explain how you will balance the centrifuge.
2. Describe two methods of protecting a light-sensitive specimen from light.

11.3 Specimen Rejection

Laboratory test results are only as good as the specimens from which they are obtained. Specimen collection and handling are pre-examination variables that only those collecting and transporting the specimen can control. Any error made before the specimen is analyzed is known as a **pre-examination error.** There is nothing medical laboratory technicians and scientists can do to the specimen to obtain quality results from inappropriately collected or handled specimens.

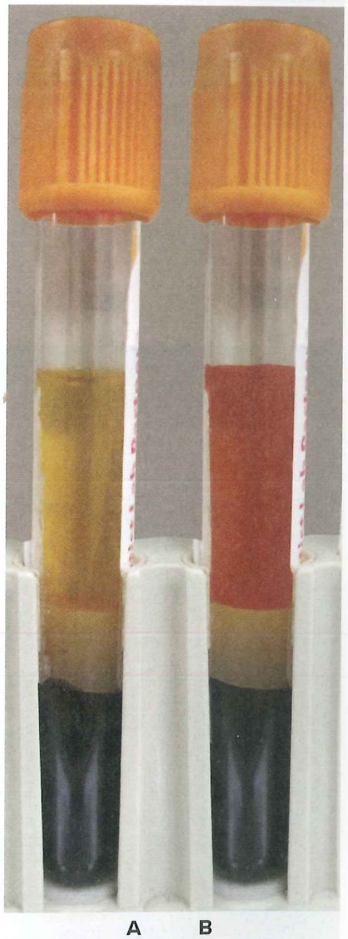
Furthermore, unless obvious characteristics are present (hemolysis, clots, underfilled tubes), errors in collection or handling may go unnoticed by those performing testing procedures. As a result, questionable results may be reported. Questionable or inaccurate results can affect patient care negatively. For this reason, phlebotomists should know the causes for specimen rejection and how to minimize the occurrence of poor-quality specimens. The following paragraphs contain more detailed information about the specific reasons for specimen rejection and re-collection.

Hemolysis

Hemolysis is the destruction of red blood cells (RBCs). The hemoglobin inside the RBCs is released into the plasma or serum and gives it a reddish color (see Figure 11-20). This color may interfere with some laboratory tests. Other substances found in RBCs, such as potassium and calcium, cause erroneous results for various laboratory tests when hemolysis is present. Although some patient conditions (such as hemolytic anemia and transfusion reactions) can lead to hemolysis, more commonly a hemolyzed specimen is the result of improper collection or handling.

The following are common causes of hemolysis:

- Not allowing the alcohol to dry prior to puncture
- Continuing to draw blood during hematoma formation
- Forcefully squeezing during dermal (capillary) puncture
- Vigorously mixing the collection tube
- Forcing blood when using a syringe transfer procedure by pushing on the plunger
- Roughly handling the specimen during transport (such as turbulence in a pneumatic tube system)



A B

Figure 11-20 Centrifuged specimens with (A) normal serum and (B) hemolyzed serum.
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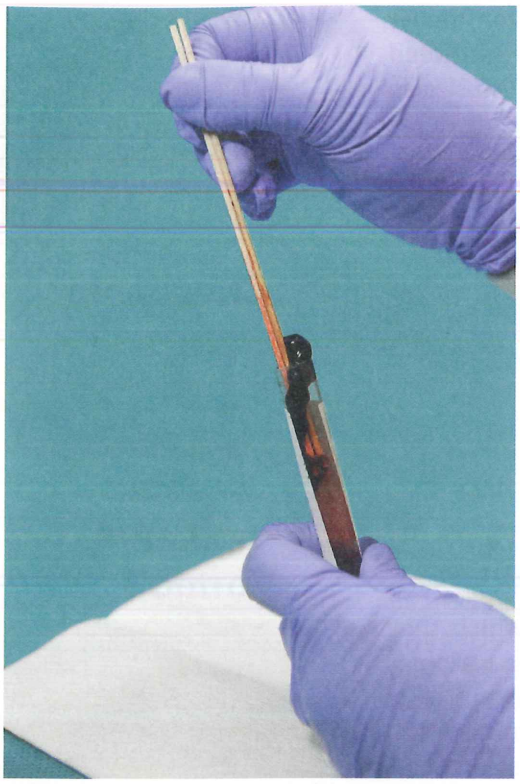

Figure 11-21 Clotted specimen.
Sandra Mesrine/McGraw-Hill Education

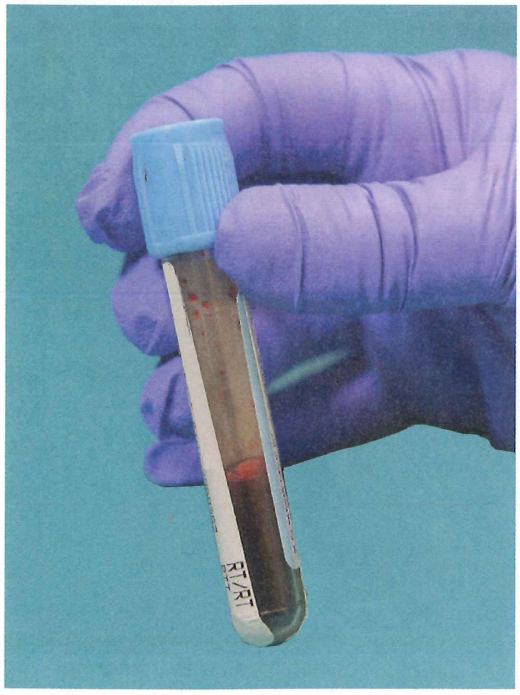

Figure 11-22 Underfilled specimen tube.
Sandra Mesrine/McGraw-Hill Education

- Freezing and thawing or heating specimens in transit (leaving specimens in outdoor courier pickup boxes or a courier vehicle without temperature control for long periods of time)

Clotted Anticoagulated Specimens

If laboratory tests require whole blood, plasma, or cells, the specimen is collected in a tube containing an anticoagulant, which is designed to prevent clotting. However, if the specimen in an anticoagulated tube does clot (see Figure 11-21), the specimen must be re-collected. If clots are not discovered by testing personnel, the results will be erroneous and, if reported, can jeopardize patient safety.

The following is a list of common causes for specimen clotting in anticoagulant tubes:

- Incorrect order of draw (clot activator tube drawn before light-blue-topped tube)
- Failure to mix each tube as it is removed from the holder or to tap a microcollection container between each drop
- Delay in transferring specimens from a syringe to an evacuated tube
- Difficult blood draws in which the blood flows very slowly into the tube
- Use of an expired tube

Incomplete Collection

An incomplete collection is often rejected as "quantity not sufficient" (QNS), meaning there is not enough specimen to perform the test (see Figure 11-22). Sometimes a QNS specimen does contain the minimum amount of blood required to run a test but is rejected because of an improper **additive-to-blood ratio** (the balance between the amount of additive or anticoagulant and the amount of blood). This imbalance will produce erroneous results, such as abnormal chemistry values, coagulation test results, and blood counts.

Always check with the laboratory prior to collecting specimens from difficult-to-draw patients so that you know what the minimum amounts are you must collect. For example, 1 mL may be adequate for performing a CBC, but not for an erythrocyte sedimentation rate (ESR), and definitely not if both are ordered. A citrate tube must always be filled to the fill level indicated on the label. The following can cause incomplete collection:

- Loss of vacuum during venipuncture
- Loss of vacuum during shipping
- Failure to purge air out of butterfly needle tubing using a discard tube
- Use of expired tubes
- Removal of the tube before its fill level is reached
- Veins collapsing during venipuncture
- Dermal (capillary) puncture site that becomes clotted before enough specimen is obtained

Incorrect Tube Collected

Specimens collected must be appropriate for the laboratory tests to be performed. If a specimen is collected using the incorrect type of tube, the specimen will be rejected and will need to be re-collected. The following are causes for incorrect collections:

- The procedure manual was not consulted or information was misinterpreted.
- The tube was delivered to the wrong laboratory section (a switch occurred).
- The wrong tube was collected by mistake.
- The requisition was misinterpreted.

Incorrect Order of Draw

As you know, the order of draw is designed to prevent specimens from being contaminated with additives that may cause erroneous results. Phlebotomists should follow the protocol established at their facility. Causes of an incorrect order of draw include not consulting the procedure manual, misinterpreting information in the procedure manual, and the tubes were collected in the wrong order by mistake.

Some things to consider to prevent an incorrect order of draw.

- CLSI standards allow for coagulation tests to be drawn without a discard tube, this applies when the phlebotomist can ensure that the venipuncture is uncomplicated and no contamination of the light-blue-topped tube will occur.
- When a winged blood collection set is used and a coagulation tube is needed first, a discard tube is used.
- Only blood culture tubes, glass nonadditive serum tubes, or plastic serum tubes without a clot activator may be collected before the coagulation tube.
- When a lavender stopper tube with EDTA which has potassium, carry over into a tube to be tested for potassium (a green-, red-, gold-, or speckle-top tube), the level of potassium may be falsely elevated leading to life-threatening medical mistakes.
- When blood cultures are collected at the same time as other lab work and not filled first, bacteria from the non-sterile stoppers of the tubes can contaminate the bottles used for blood cultures.

Hemoconcentration or Contamination

The effects of hemoconcentration (prolonged tourniquet application, discussed in the chapter *Venipuncture*) and contamination by intravenous (IV) fluids (collecting blood from a site above an IV) are not easily detected. Laboratory personnel may question phlebotomists about collection procedures when they obtain results that do not make sense or do not pass **delta check.** The delta check is a comparison of the results with previous results for the same test on the same patient. If laboratory personnel suspect hemoconcentration or contamination, the specimen will need to be re-collected. If no apparent cause can be determined for questionable results, the specimen may still need to be re-collected.

Icterus and Lipemia

Two interfering substances over which the phlebotomist has no control are icterus and lipemia. **Icteric** plasma and serum appear dark yellow to greenish yellow in color due to the presence of an increased amount of bilirubin, the

substance made during the breakdown of red blood cells. This abnormal color may interfere with some chemistry tests, such as creatinine. **Lipemia** is the presence of abnormal amounts of fats in the blood and can make plasma or serum appear cloudy. This cloudiness can interfere with laboratory tests, such as hemoglobin levels. Figure 11-23 compares normal serum with lipemic and icteric sera.

Special Requirements Not Followed

As discussed earlier, some laboratory tests require special specimen handling. If these requirements are not followed, the specimen will be rejected and then it must be re-collected. The following are special handling requirements:

- The specimen must be protected from light.
- The specimen must be kept at the appropriate temperature.
- Alcohol must not be used during site preparation.
- A tourniquet must not be used during specimen collection.
- The specimen must be centrifuged and separated within the required timeframe.

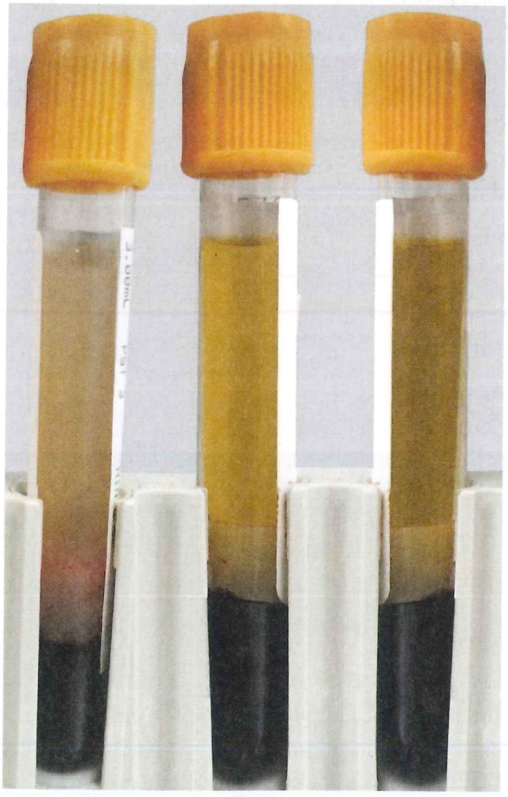

Figure 11-23 Comparison of serum color and transparency: (A) lipemic serum appears milky, (B) normal serum is clear and yellow in color, and (C) icteric serum may be clear but has an olive-green color due to the presence of excessive amounts of bilirubin.
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Documentation Errors

As you may recall from the chapter *Blood Collection Equipment,* specimens must be labeled with certain required information. The laboratory may reject specimens with inadequate or missing documentation, depending on the severity of the omission. In addition, misidentified specimens will be rejected. If a specimen is obtained from the wrong patient, not only will the specimen be labeled incorrectly, but the error may also go undetected. This can result in delay of treatment for one patient and inappropriate treatment being given to the other. Sometimes a labeling error is detected at the time of test performance, if the test result produces a delta check error. Unexplained delta checks will initiate a rejection and re-collection of the specimen. Reasons for specimen rejection due to documentation include the following:

- An unlabeled specimen
- A mislabeled specimen (labeled with another patient's identification information)
- A specimen with two labels containing different patient information
- Missing documentation for a chain-of-custody specimen
- Labels placed on the wrong tubes for the same patient (for example, a CBC label on a chemistry tube and vice versa, which can usually be resolved without re-collecting the specimen)
- A special labeling procedure that was not followed (such as blood bank labeling, which is discussed in the chapter *Special Phlebotomy Procedures*)

Customer Service and Specimen Rejection

Communicate & Connect

Customer satisfaction with your laboratory and facility may suffer if patients perceive that they are not receiving quality care. Your role as the phlebotomist includes making sure your customer (the patient) is comfortable in your presence and confident in your ability to provide adequate care. Consider the patient's feelings when you must repeat a blood collection. The patient may be angry at the need for a repeat collection or may express doubt about your ability to perform the procedure properly.

Be sure to communicate that many factors can contribute to the need to collect a new specimen. Let the patient know you are sorry that you need to collect the specimen again, but it is important that a good specimen and accurate results are obtained. Always taking time to collect, handle, and process specimens correctly the first time will help ensure accurate and timely results and will help avoid the need for a second collection.

Checkpoint Questions 11.3

1. How can a phlebotomist help minimize the chance of hemolysis?
2. How does a delta check help laboratory personnel determine whether hemoconcentration has occurred in a blood specimen?

Chapter Summary

Learning Outcome	Key Concepts/Examples	Related NAACLS Competency
11.1 Explain methods for transporting and processing blood specimens for routine and special testing and to reference laboratories.	• Blood and other specimens must be transported to the laboratory in a timely manner by hand delivery, a pneumatic tube system, or automated transport systems. • Packaged specimens for transport to the laboratory from client sites or to reference laboratories must meet safety standards for specimen handling and transport. • Proper documentation of specimen collection and transport allows laboratory and other healthcare personnel to track the specimen and approximate a test completion time.	4.4, 7.1, 7.3, 7.4, 7.5

11.2 Recognize the types of specimens that require special handling and the criteria for handling each specimen.	• Correct specimen handling and processing requirements include temperature control, exposure to light, and use of special draw techniques (no alcohol, no tourniquet, coagulation).
	• Specimen handling for legal specimens must follow established practices for maintaining the chain of custody.
	  • For blood alcohol testing to be performed, the patient must consent or a legal document must be obtained. The venipuncture site should be cleaned with something other than alcohol.
	  • A forensic specimen is collected as evidence to help prove or disprove a link between an individual and objects, places, or other individuals.
	• Toxicology specimens are collected to detect poisons, drugs, and medications.
	• Proper separation of specimens may require centrifugation and aliquoting of specimens, which involves the safe use of a centrifuge and careful attention to labeling and documentation.
		4.5, 7.5, 7.7, 9.9

11.3 List the circumstances that would lead to re-collection or rejection of a patient sample.	Specimen rejection may occur due to improper collection technique or handling and processing errors. Reasons for specimen rejection include clots, contamination, hemoconcentration, hemolysis, incomplete collection, incorrect tube or order of draw, inadequate or missing documentation, failure to follow special requirements, and failure of delta checks due to unexplainable changes in test results and specimen collection from the wrong patient.	5.5, 7.6

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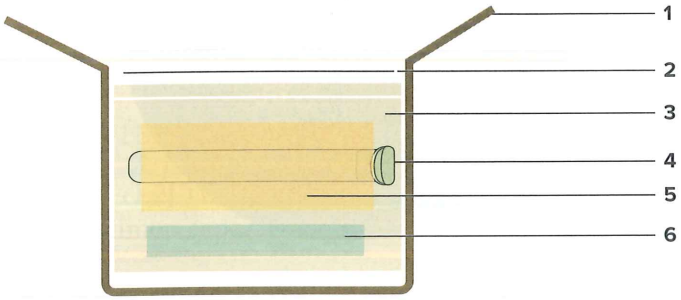
Chapter Review

A: Labeling

Label the essential parts of a properly packaged specimen for shipping to an out-of-state reference laboratory.



1. [LO 11.1] _____
2. [LO 11.1] _____
3. [LO 11.1] _____
4. [LO 11.1] _____
5. [LO 11.1] _____
6. [LO 11.1] _____

B: Matching I

Determine whether each centrifuge is balanced or unbalanced. [LO 11.2]

a. balanced
b. unbalanced

____7.

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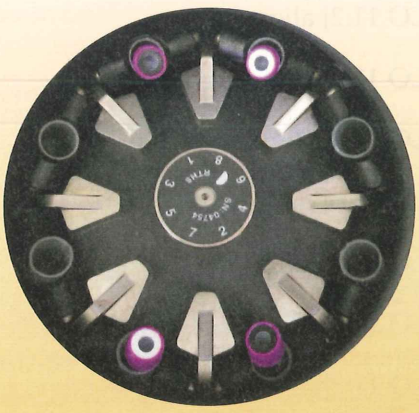
____8.



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___9.

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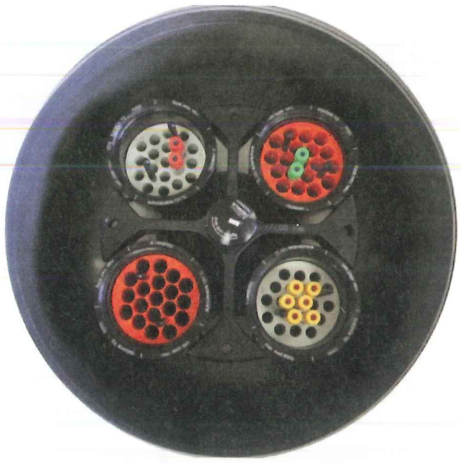
___10.



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___11.

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C: Matching II

Match each term with its definition.

___**12.** [LO 11.2] aerosol

___**13.** [LO 11.2] aliquoting

___**14.** [LO 11.2] centrifuging

___**15.** [LO 11.3] clotted

___**16.** [LO 11.3] delta check

___**17.** [LO 11.3] hemolyzed

___**18.** [LO 11.2] glycolysis

___**19.** [LO 11.2] light-sensitive

___**20.** [LO 11.3] pre-examination

___**21.** [LO 11.1] STAT

a. amount of change in a test from one time to the next on the same patient

b. errors that occur prior to specimen testing

c. fine mist

d. obtain or process immediately

e. portion of a specimen

f. process of separating cells from the liquid portion of blood

g. specimens in which plasma has changed to serum and now contains a solid mass of cells

h. specimens in which red blood cells have been destroyed

i specimens in which presence of light causes chemical changes

j. conversion of glucose to lactic acid

D: Fill in the Blank

Write in the word(s) to complete each statement.

22. [LO 11.1] Specimens within a hospital facility can be hand-delivered to the hospital laboratory or sent in the _____ system.

23. [LO 11.1] Information for specimen tracking is entered, by phlebotomists and couriers, into the _____.

24. [LO 11.2] Testing for cold agglutinins is done for patients suspected of having conditions such as atypical pneumonia; these patients may be infected with the organism _____.

25. [LO 11.2] Specimens that need to be transported chilled should be _____.

26. [LO 11.2] The lid on the _____ machine should remain properly closed during the specimen separation process.

27. [LO 11.2] The specimen separation process includes _____ and then _____ into transfer tubes.

28. [LO 11.1] Specimens on critically ill patients may need to be collected first and immediately delivered to the laboratory. These specimens are usually labeled as _____.

29. [LO 11.2] Blood alcohol and forensic specimens often require a(n) _____ form to prove that the specimen has remained in the control of authorized personnel from the time of its collection until the laboratory test is performed.

E: Sequencing

Place the events for processing specimens to ship to a reference laboratory in the correct order (from 1 to 10).

30. [LO 11.1] _____ Attach specimen information to container.

31. [LO 11.1] _____ Centrifuge the specimen, if required.

32. [LO 11.1] _____ Label the transfer tube.

33. [LO 11.1] _____ Obtain original specimen.

34. [LO 11.1] _____ Pipet specimen aliquot into transfer tube.

35. [LO 11.1] _____ Place ice pack into Styrofoam container.

36. [LO 11.1] _____ Place package into shipping container.

37. [LO 11.1] _____ Place wrapped transfer tube into Styrofoam container.

38. [LO 11.1] _____ Seal transfer tube.

39. [LO 11.1] _____ Wrap tube in absorbent material.

F: Short Answer

40. [LO 11.2] You need to collect a specimen for cold agglutinins on a patient. How will you maintain the specimen at the correct temperature while transporting it to the laboratory? What will you do once you arrive at the laboratory section that is responsible for this test?

41. [LO 11.2] You must collect blood for an alcohol level that may be used in a court of law. What procedures do you need to follow for this blood collection and why?

G: Case Studies/Critical Thinking

42. [LO 11.3] You are working in the laboratory's processing area and notice that a specimen you were just given was drawn more than two days ago. This is the same blood sample for which a doctor just called for the results. The doctor was upset and wanted the results immediately. What would you do?

43. [LO 11.2] You have finished labeling all of Mrs. Diaz's blood tubes when you notice that one sample was supposed to be put on ice immediately. You have been talking to Mrs. Diaz for the last 10 minutes. What would you do?

44. [LO 11.3] You need to collect a lactic acid on a patient who has had blood drawn before. He is pumping his fist in preparation for the blood collection. What should you do and why?

H: Exam Prep

Choose the best answer for each question.

45. [LO 11.1] Pneumatic tube systems are used to transport specimens from a

a. hospital unit to the laboratory.

b. physician office to a hospital laboratory.

c. hospital laboratory to a reference lab.

d. courier's vehicle to the laboratory.

46. [LO 11.1] Specimens for tests that are ordered STAT must be

a. verified with the laboratory manager prior to collection.

b. collected by the physician.

c. delivered to the laboratory immediately.

d. collected last when drawing several patients.

47. [LO 11.1] Specimen lockboxes are used

a. when dropping off specimens at the main laboratory.

b. by clients to store specimens for courier pickup and delivery to the laboratory.

c. to transport specimens in courier vehicles.

d. to hand-deliver specimens from within the facility.

48. [LO 11.1] Which of the following does *not* represent proper data documentation for specimen tracking?

a. Bar-coding specimen information upon delivery to the laboratory

b. Centrifuging specimens within 5 minutes of collection

c. Entering collection information into the computer

d. Recording the time of collection and initials on the specimen container

49. [LO 11.1] Containers for specimen transport must be

a. airtight.

b. light-tight.

c. microbe-free.

d. watertight.

50. [LO 11.1] Which of the following specimen transport methods will have the *least* effect on specimen quality?

a. Leaving a specimen in a pickup box located outside during winter months

b. Leaving a specimen in the courier's vehicle for several hours during summer months

c. Shipping specimens on dry ice to a reference laboratory

d. Using the facility's nonvalidated pneumatic tube system

51. [LO 11.2] When aliquoting specimens, a shield or splashguard is used to protect the phlebotomist from

a. aerosols.

b. bacteremia.

c. normal flora.

d. septicemia.

52. [LO 11.2] Which statement describes proper centrifuge operation?

a. Centrifuge specimens within 5 minutes of collection.

b. Balance specimens by placing tubes of equal size and volume opposite each other.

c. Never centrifuge plasma specimens with serum specimens.

d. Remove tops from tubes before centrifuging.

53. [LO 11.2] Which of the following specimens must be placed on ice during transport to the laboratory?
    a. Cold agglutinins
    b. Lactic acid
    c. Specimens sent via pneumatic tube
    d. Tubes that will be centrifuged

54. [LO 11.2] Protecting a specimen from the effects of heat can be accomplished by *(Choose all that apply.)*
    a. collecting the specimen in an amber microcollection container.
    b. wrapping the specimen tube with foil.
    c. wrapping the specimen tube with absorbent material.
    d. placing the specimen on ice.

55. [LO 11.2] Transporting a specimen for cold agglutinin testing includes *(Choose all that apply.)*
    a. placing the specimen in a portable heating block.
    b. wrapping the specimen tube with foil.
    c. wrapping the specimen tube with a tissue warmer.
    d. placing the specimen on ice.

56. [LO 11.2] Substances that need protection from the effects of light include *(Choose all that apply.)*
    a. alcohol.
    b. bilirubin.
    c. calcium.
    d. carotene.

57. [LO 11.2] Alcohol pads are not used during blood collection for alcohol mainly because
    a. alcohol from alcohol pads will interfere with the test.
    b. patients may be allergic to alcohol.
    c. evidence presented in a court of law will be invalidated.
    d. alcohol pads will absorb the alcohol from the patient.

58. [LO 11.2] Contamination of the specimen by additional lactic acid during blood collection for lactic acid may occur when
    a. a tourniquet is not used during collection.
    b. an alcohol prep pad is used during collection.
    c. the patient makes a tight fist during collection.
    d. the specimen is placed on ice after collection.

59. [LO 11.3] Tubes that are not completely filled may be rejected because
    a. all the vacuum is not used up in the tube.
    b. the extra airspace makes sampling difficult.
    c. the ratio of blood to anticoagulant is out of balance.
    d. all tests require absolutely filled tubes.

60. [LO 11.3] Hemolysis occurs due to
    a. allowing alcohol to air-dry prior to puncture.
    b. forcing syringe-drawn specimens into evacuated tubes.
    c. gently massaging a dermal (capillary) puncture site.
    d. mixing the collection tube too slowly.

61. [LO 11.3] Clotting of specimens occurs due to
    a. not allowing alcohol to air-dry prior to puncture.
    b. quickly transferring syringe blood into evacuated tubes.
    c. placing collection tubes into a test tube rack without mixing.
    d. tapping microcollection containers on a hard surface during collection.

62. [LO 11.3] Inadequately filled tubes may result from *(Choose all that apply.)*
    a. loss of vacuum during venipuncture.
    b. veins collapsing during venipuncture.
    c. premature clotting of a dermal (capillary) puncture site.
    d. use of expired evacuated blood collection tubes.

63. [LO 11.3] Test results that do not compare with previous results *(Choose all that apply.)*
    a. may be due to contamination with IV fluids.
    b. may result from prolonged tourniquet application.
    c. fail the delta check test.
    d. usually have no apparent cause.

64. [LO 11.3] Specimens that are rejected for documentation errors include *(Choose all that apply.)*
    a. unlabeled specimens.
    b. specimens whose label is missing the phlebotomist's identification.
    c. specimens labeled with another patient's information.
    d. specimens whose label is upside-down.

65. [LO 11.2] Which of the following is *not* required information on a chain-of-custody form?

a. Length of time each person had the specimen
b. Initial volume of the specimen
c. Name of each person receiving the specimen
d. Name of each person from whom the specimen was received

66. [LO 11.2] Which of the following specimens must be transported to the laboratory on an ice slurry?

a. ammonia
b. blood gasses
c. lactate/lactic acid
d. all of these

67. [LO 11.2] For which of the following specimens must a non-alcohol antiseptic be used for specimen collection site cleansing?

a. alcohol
b. blood gasses
c. lactate/lactic acid
d. all of these

68. [LO 11.1] Specimens for which of these vitamin levels must be protects from light while being transported to the laboratory?

a. Vitamin A
b. Vitamin C
c. Vitamin D
d. Vitamin K

69. [LO 11.1] Keeping a specimen warm while being transported to the laboratory is vital to the accuracy of which test?

a. blood nitrogen
b. cold agglutinins
c. platelet function
d. vitamin levels

70. [LO 11.2] Which of the following specimens must be collected without the use of a tourniquet?

a. alcohol
b. coagulation tests
c. lactate/lactic acid
d. all of these

71. [LO 11.1] Which of the following specimens must be delivered to the laboratory immediately for processing, even if not ordered as a STAT?

a. basic metabolic panel
b. complete blood count
c. platelet function study
d. therapeutic drug level

NAME: _____ DATE: _____

COMPETENCY CHECKLIST: SPECIMEN HANDLING: TEMPERATURE-SENSITIVE SPECIMENS

Procedure Steps	Practice 1	Practice 2	Practice 3	Performed Yes	Performed No	Performed Master
Preprocedure						
1. Examines the requisition.						
2. Performs the patient identification procedure and puts on gloves.						
3. Performs site selection and the preparation procedure.						
4. Prepares an ice bath or specimen warming equipment.						
5. Performs the specimen collection procedure.						
6. Performs the postcollection patient care procedure.						
Procedure						
7. Places the labeled specimen immediately into the correct temperature control equipment.						
8. Labels the outside of the ice bath or warming device.						
Postprocedure						
9. Immediately transports the specimen to the laboratory.						
10. Ensures that cooling or warming is maintained while transporting the specimen.						
11. Centrifuges specimens for the specified time, if required.						
12. Places the specimen in the appropriate laboratory device (incubator, water bath, refrigerator, etc.).						
13. Alerts laboratory staff of the temperature-sensitive specimen.						
14. Removes gloves and washes hands.						
15. Documents the specimen collection.						

COMMENTS: _____

_____

SIGNED

EVALUATOR: _____

STUDENT: _____

NAME: _____ DATE: _____

COMPETENCY CHECKLIST: SPECIMEN HANDLING: LIGHT-SENSITIVE SPECIMENS

	Practice			Performed		
Procedure Steps	**1**	**2**	**3**	**Yes**	**No**	**Master**
Preprocedure						
1. Examines the requisition.						
2. Performs the patient identification procedure and puts on gloves.						
3. Performs the site selection and the preparation procedure.						
4. Prepares foil for the evacuated tubes or uses an amber microcollection containers.						
5. Performs the specimen collection procedure.						
6. Performs the postcollection patient care procedure.						
Procedure						
7. Wraps the labeled specimen with foil or uses amber container if available.						
8. Labels the outside of the foil or container.						
Postprocedure						
9. Immediately transports the specimen to the laboratory.						
10. Ensures that the specimen remains protected from light.						
11. Alerts laboratory staff of the light-sensitive specimen.						
12. Removes gloves and washes hands.						
13. Documents the specimen collection.						

COMMENTS: _____

_____

SIGNED

EVALUATOR: _____

STUDENT: _____

NAME: _____ DATE: _____

COMPETENCY CHECKLIST: MAINTAINING A CHAIN OF CUSTODY

Procedure Steps	Practice 1	Practice 2	Practice 3	Performed Yes	Performed No	Performed Master
Preprocedure						
1. Identifies the patient.						
Procedure						
2. Collects the specimen, taking care to guard against tampering.						
3. Places the specimen in a locked container or seals the tube with a tamperproof label and wax to prevent tampering.						
4. Correctly and completely fills out the chain-of-custody form.						
5. Asks the patient to sign or initial the form, if required.						
Postprocedure						
6. Places one copy of the chain-of-custody form with the specimen in a sealed envelope.						
7. Attaches a second copy of the chain-of-custody form to the outside of the envelope.						
8. Ensures that each person who handles the specimen initials the chain-of-custody form on the envelope.						
9. Places a copy of the chain-of-custody form in the patient's file.						

COMMENTS: _____

_____

SIGNED

EVALUATOR: _____

STUDENT: _____

NAME: _____ DATE: _____

COMPETENCY CHECKLIST: CENTRIFUGE OPERATION

Procedure Steps	Practice 1	Practice 2	Practice 3	Performed Yes	Performed No	Performed Master
Preprocedure						
1. Puts on gloves.						
2. Transports specimens to the centrifuge area.						
3. Safely and conveniently places the specimens.						
4. Opens the lid of the centrifuge.						
Procedure						
5. Inserts the tubes so that they are balanced.						
6. Does not remove the caps from the tubes.						
7. If a cap is missing, covers the end of the tube.						
8. Closes the centrifuge lid.						
9. Locks the lid in place.						
10. Sets the centrifuge time and speed correctly.						
Postprocedure						
11. Allows the centrifuge to stop completely.						
12. Put on appropriate PPE.						
13. Opens the lid after the centrifuge has stopped.						
14. Observes special handling instructions.						
15. If tubes are broken, cleans appropriately.						
16. Disposes of used supplies appropriately.						
17. Removes gloves and washes hands.						

COMMENTS: _____

_____

SIGNED

EVALUATOR: _____

STUDENT: _____