CHAPTER OBJECTIVES

■ Identify the different parts of a syringe.
■ Identify the different types of syringes available and their unique characteristics.
■ Select the appropriate syringe to measure a given volume based on the syringe’s calibrations.
■ Identify the different parts of the needle.
■ Describe filter needles, filter straws, and vented needles.
■ Identify when a filter needle or filter straw is used.
■ Identify when a vented needle is used.
■ Describe the filters used to sterilize products.
■ Explain the advantages of a needleless system.
■ Explain the difference between large-volume parenterals and piggybacks.
■ Compare the advantages and disadvantages of glass bottles versus plastic bags.
■ Explain the characteristics of a single-dose vial and a multiple-dose vial.
■ Describe the advantages and disadvantages of vials and ampules.
■ Explain HEPA filtration.
■ Compare and contrast the use of laminar airflow workbenches (LAFWs), biological safety cabinets (BSCs), and compounding aseptic isolators.
■ Describe the proper cleaning procedures for an airflow hood.

KEY TERMS

ampule—a sealed glass container that contains a single dose of medication
bevel—the slanted, pointed tip of a needle
biological safety cabinet (BSC)—a vertical flow hood that uses HEPA-filtered air that flows vertically (from the top of the hood towards the work surface) to provide an aseptic work area
calibrations—graduated markings on the outside of a syringe barrel
catheter—a tiny delivery or drainage tube inserted into a vein, artery, or body cavity
critical surface—any surface that comes into contact with a sterile product, container, or closure
delivery system—the pieces of equipment that allow a drug to follow a designated route of administration into the body
filter needle—a needle with a filter molded into the hub designed for one-time use only; used to remove glass particles from a solution
filter straws—thin, sterile straws with a filter molded into the hub; used to draw fluid from an ampule
gauge—the diameter of the opening of a needle, or the lumen
HEPA filter—a high-efficiency particulate air filter used in all aseptic processing areas
hypodermic needle—a needle that fits on the end of a syringe used to inject fluids into or withdraw fluids out of the body
intravenous piggybacks (IVPBs)—IV bags that are administered on a set schedule
laminar airflow workbench (LAFW)—a workbench that uses HEPA-filtered air that flows horizontally (from the back of the bench towards you) to provide an aseptic work area
lumen—the hollow part of a needle
vented needle—a needle with side openings used to reconstitute powdered medication
As a pharmacy technician, you’ll frequently handle equipment used in the delivery, preparation, and storage of CSPs. In addition to supplies, there are standard pieces of equipment to assist you in creating a sterile product. It’s important to know what these provisions are used for, how to use them properly, and how to keep them sterile. Although the equipment may differ based on the facility, there are universal processes and standards in place to ensure aseptic production.

In this chapter, you will learn how to identify and describe different types of equipment used in delivery systems. These include items such as syringes, needles, vials, ampules, and IV bags. You’ll also learn about the different workbench spaces and filtration systems used for CSP preparation.

**DELIVERY SYSTEMS**

As you know, the pharmacy technician prepares many sterile compounds. Each of these compounds is designed to use a specific route of administration in order to be effective. The pieces of equipment that allow a drug to follow its designated route of administration are referred to as the **delivery system**. In the following sections, you will learn about the equipment used in drug delivery systems.

**Syringes**

One of the most familiar pieces of a delivery system is a medical syringe. Syringes are made of glass, plastic, or metal. You will most commonly use ones made of plastic. They are used for:

- injection
- irrigation
- withdrawal of fluids

**Parts of a Syringe**

The parts of a syringe (Fig. 4-1) include:

- tip
- rubber plunger tip
- barrel
- flange
- plunger
- flat knob

All syringes include a hollow barrel with a close-fitting plunger that is attached to one end. A tip designed to connect to a needle, catheter, or other attachment is at the other end of the barrel. Some syringes are designed to have nothing connect to them, such as those used for oral dosing or irrigation.

![Figure 4-1 Various parts of a hypodermic syringe.](image_url)

When the tip end of the syringe is inserted into a liquid and the plunger is pulled out, the barrel fills with liquid. When the plunger is pushed in, the liquid is forced out through the syringe tip.

**Kinds of Syringes**

Syringes vary in size from 1 mL (or 1 cc) to 60 mL (or 60 cc). The size used depends on the volume needed.

All hypodermic syringes are marked with calibrations showing milliliters or smaller divisions depending on the size of the syringe.

Two special types of syringes used to administer medications are tuberculin syringes and insulin syringes.

**Tuberculin Syringe**

Tuberculin (TB) syringes are narrow and have a total capacity of 1 mL. Each TB syringe has 100 calibration lines. TB syringes are used for:

- newborn doses
- pediatric doses
- intradermal skin tests
- small doses in adults
- injections just beneath the skin

**Insulin Syringe**

Insulin syringes are used only for administering insulin to diabetic patients. The insulin syringe has a total capacity of 1 mL, but uses a different calibration system than other syringes.

The 1-mL volume is marked as units (U). The units represent the strength of the insulin per milliliter. Most of the insulin that is used today is U-100, which means that it has 100 units of insulin per milliliter. On the syringe, large lines mark each group of ten units. Five smaller lines divide the ten units into groups of two. Usually, each small line represents two units, but in some syringes it may be one line to one unit.

**Syringe Tips**

Some syringes are named for the type of tip they have. Here are some you are likely to encounter:

- luer-lock—a syringe tip with a screw-on fitting for the needle; keeps leaks to a minimum
Critical Surfaces of Syringes

Part of practicing sterile technique is making sure that all critical surfaces remain free from contamination. A critical surface is defined as any surface that comes into contact with a sterile product, container, or closure.

Certain parts of a syringe, such as the tip and the plunger, are considered critical surfaces. Special care must be taken to assure that these surfaces remain sterile and that the contents inside do not become contaminated. When holding a syringe, you should hold it by the barrel. You can use the flat knob on the end to move the plunger.

In Chapter 2, you learned about the importance of the laminar airflow workbench, or LAFW. In order to preserve the syringe’s sterility, you must open the syringe package within the air space of the LAFW.

Some syringes are manufactured with a needle and cap or a protective covering over the tip. If the syringe is packaged with just a protective covering, you must not remove the covering until a needle is ready to be attached. You should complete this process as quickly as possible to avoid contamination.

Syringe Calibrations

Medical syringes have graduated markings on the outside of the barrel. These markings are called calibrations, and they differ according to the size and type of syringe. Remember, an insulin syringe is marked in units for measuring insulin and a tuberculin syringe is marked in milliliters up to 1 mL per syringe.

Let’s take a look at a few more syringes.

- The 3-mL syringe is marked for each tenth: 1.1 mL, 1.2 mL, 1.3 mL, etc.
- The 5-mL syringes are also marked in tenths, but only reflect every two tenths: 3.2 mL, 3.4 mL, 3.6 mL, etc.
- The 10-mL syringes are also marked in tenths and reflect every two tenths: 3.2 mL, 3.4 mL, 3.6 mL, etc.
- The 20-mL, 30-mL, 50-mL, and 60-mL syringes are marked in whole numbers, or 1-mL increments: 1 mL, 2 mL, 3 mL, etc.

Measuring from the Plunger Tip

Remember, the plunger is the part of the syringe that draws the fluid into the barrel and then pushes it out.

When measuring fluid, you must be alert to which type of tip is on the plunger. Some plunger tips come to a point, while others are flat.

Regardless of the type of tip, you will measure from where the plunger hits the side of the syringe barrel.

Measuring Accurately with a Syringe

Choosing the right syringe for the right amount of fluid is key to using a syringe accurately. For example, you wouldn’t want to use a 1-mL tuberculin syringe to draw 2.5 mL of fluid, because you would have to fill it three times. Likewise, you wouldn’t use a 30-mL syringe to draw 2 mL of fluid.

When measuring volumes, you’ll have to round numbers up or down. Here is a list of rounding suggestions based on syringe volumes:

- 1-mL syringe—accurate to 0.01 mL
- 3-mL syringe—accurate to 0.1 mL
- 5-mL syringe—accurate to 0.2 mL
- 10-mL syringe—accurate to 0.2 mL
- syringes larger than 10 mL—accurate to 1 mL
Until you are comfortable with measuring, you should avoid filling a syringe above 80% of the total volume capacity.

Needles

The hypodermic needle is a needle that fits onto the end of a syringe. It’s used to inject a specific amount of fluid into, or withdraw a specific amount of fluid out of, the body.

Parts of a Hypodermic Needle

You’ll learn that hypodermic needles can be different lengths and different gauges, but they all share the same basic parts. Figure 4-3 shows a diagram and description of these parts.

- **Hub**—the base that attaches to the syringe
- **Shaft**—the longest section
- **Bevel**—the slanted, portion of the needle
- **Heel**—the edge of the bevel closest to the hub
- **Tip**—the end of the needle furthest from the hub

Gauge of a Needle

The **gauge** of a needle refers to the diameter of the opening, or lumen. Needle gauges usually range from 28 to 16, although insulin needles are as small as 30 gauge. Here’s the tricky part to remember—the *larger* the gauge, the *smaller* the opening. A 30 gauge needle, for example, has a much smaller opening than an 18 gauge needle.

Length of a Needle

Length is another variation of a hypodermic needle. Needle length depends on the route of administration as well as on the body part chosen for injection. Remember from Chapter 2 that a needle may be inserted below the skin, into a vein, or deep into thick muscle tissue.

For example, insulin syringes have a small gauge and a shorter needle. They are used for subcutaneous injections. This helps make daily insulin injections easier and not as painful.

Filter Needle Use

Only use a filter needle to withdraw from an ampule or to inject after withdrawing from an ampule. If you use it both to withdraw and to inject, then the filter particles are injected.

Gauges of a Needle

- **0.22-micron filter**—removes bacteria and particulates
- **0.45-micron filter**—removes general particulates
- **1.2-micron filter**—removes fungi and particulates
- **5-micron filter**—coarse filter; removes glass shards and other particulates

As a pharmacy technician, you’ll encounter filter needles, filter straws, and vented needles.

Filter Needles

Filter needles are molded into the hub of the needle and are designed for one-time use only. They remove glass shards that may contaminate a solution when using a glass ampule.

Filter Straws

A filter straw is a thin, flexible, sterile straw with a filter in the hub. Filter straws are used to withdraw a single dose of fluid from a sterile glass ampule. Since it’s not a needle, it cannot be used to inject.

Vented Needles

Vented needles are used primarily for reconstituting a powdered medication. This type of needle usually has side openings and a thin wall that act as filters to help minimize spraying and foaming during the reconstitution process. You’ll learn more about reconstitution in Chapter 7.

Needless Systems

Instead of using a needle and syringe to withdraw a volume of drug from a vial or ampule and injecting...
it into a bag, these systems allow for the mixing of the drug and the base solution without the use of a needle and syringe. Some of the systems consist of a vial that is attached directly to the IV bag for mixing. Other systems have the drug and base solution in one bag with a barrier in between. The bag is then rolled up to puncture the barrier and mix the two solutions.

**INTRAVENOUS SUPPLIES**

There are numerous containers and supplies needed for the delivery of sterile products. As a pharmacy technician, it is important for you to be familiar with these. You’re likely to use some of them on a daily basis. Here are some you’ll learn about:

- IV administration set
- large-volume IV
- intravenous piggybacks (IVPBs)
- intravenous bags and bottles

**Intravenous Administration Set**

The parts of an IV system that determine the flow rate of the fluid or medication is called the IV administration set. There are two different types of sets:

- vented set—used for containers that have no venting system (IV bottles)
- unvented set—used for containers that have their own venting system or do not require venting (IV bags)

IV administration sets come with various features including ports for infusing secondary medications and filters for blocking microbes.

The tubing also varies. Some types are designed to enhance the proper functioning of devices that help regulate the infusion rate. Other tubing is used specifically for continuous or intermittent infusion or for infusing parenteral nutrition and blood.

There are two main types of IV bags as well:

- large-volume
- intravenous piggybacks (IVPBs)

**Large-Volume Intravenous Bags**

A large-volume IV bag is sometimes called a large-volume IV drip or a continuous infusion. These are administered continuously and are often used for fluid replacement or for maintenance fluids. A large-volume IV bag usually contains one of the following amounts of fluid:

- 500 mL
- 1 L (1000 mL)

**Intravenous Piggybacks**

The other type of IV bagging, intravenous piggybacks (IVPB), are administered on a set schedule (e.g., twice a day, three times a day). IVPB bags are generally smaller than large-volume IV bags. This makes sense since they are added on, or “piggybacked,” onto a large-volume IV bag.

For example, solutions of antibiotics are often piggybacked onto a large-volume IV bag. A typical IVPB bag contains one of the following amounts of fluid:

- 250 mL
- 100 mL
- 50 mL

**Intravenous Bags and Bottles**

IV solutions are most commonly prepared in flexible plastic bags, or glass bottles. Both bags and bottles are typically available in five sizes:

- 50 mL
- 100 mL
- 250 mL
- 500 mL
- 1000 mL

The most common type of container used is the flexible IV bag. There are many advantages to using flexible plastic bags over glass bottles. Plastic bags:

- are lighter than glass bottles
- are less expensive than glass bottles
- are easy to see through
- are non-breakable
- take up less volume than plastic or glass bottles

Glass bottles are usually used when the medication is not compatible in a plastic bag due to either absorption or adsorption.

- Absorption—the drug is absorbed into the plastic bag (i.e., nitroglycerin)
- Adsorption—the drug is adsorbed onto the surface of the plastic bag (i.e., insulin)

Both of these result in a loss of drug. Nitroglycerin is typically made in a glass bottle. Insulin, although it is adsorbed, is typically dispensed in plastic with the adsorption taken into account.

**DOSAGE CONTAINERS**

Medications are supplied from the manufacturer in different types of containers and volumes. Depending on the medication, the manufacturer may package their product in a single-dose vial, multiple-dose vial, or an ampule.
**Ampules**

An ampule is a sealed container made entirely of glass containing a single dose of medication. Once you open an ampule and remove the contents with a filter needle, you must discard the container. Remember, ampules are intended for one-time use only.

When you open an ampule, tiny shards of glass may mix in with the contents. You can extract these unwanted particles by using a filter needle or straw. The filter straw can only be used to withdraw contents from an ampule. The filter needle should only be used one time – to withdraw or to inject. Remember that you must discard the filter needle or straw after using it.

Also, you should always open ampules in an airflow hood using the following procedure:

**Single-Dose Vials**

Single-dose vials contain one dose of medication and are discarded after one use. For this reason, manufacturers do not add unnecessary preservatives. Preservatives are extremely harmful in situations such as the following:

- pediatric dilutions
- epidurals (an injection of anesthesia into the areas surrounding the spinal column)
- intrathecal (an injection of anesthesia into the areas surrounding the spinal column; usually given during birthing process in place of an epidural)

The top of a single-dose vial has a rubber stopper. The needle pierces the stopper in order to draw fluid. You must insert the needle correctly into the stopper (this is known as “coring”). Otherwise, rubber pieces may break off into the solution, causing contamination.

Even though single-dose vials are designed for one time use, they may be reused again for a limited period of time. You must document the date and time of the first puncture in order to use the remaining contents in the vial.

**Multiple-Dose Vials**

Multiple-dose vials allow you to use the contents more than once. This means that the rubber stopper of a multiple-dose vial is punctured more than once, thereby exposing the contents of the vial to air. Because of this, multiple-dose vials contain preservatives to keep the contents stable.

All vials should be dated and stored according to the manufacturer’s requirements. Check stored vials frequently and discard those that are no longer considered stable. Remember that stability is the ability of a CSP to remain effective until used, or until the expiration date has been reached.

**PROCEDURE**

**Opening Ampules**

1. Make sure all of the drug is out of the top and neck of the ampule.
2. Swab the neck of the ampule with IPA.
3. Allow the ampule to dry. Place the head of the ampule between the thumb and index finger on one hand. Hold the body of the ampule by the thumb and index finger of the other hand. You can place a clean swab on the neck of the ampule to prevent cuts and spraying of glass.
4. Open the ampule to the side of the hood away from the HEPA filter.
5. If the ampule has a dot on it, face the dot in the opposite direction as the ampule is being broken.
6. Exert pressure on both thumbs.
7. Push the ampule away from you in a quick snapping motion. The neck of the ampule should break. If it does not, try turning the ampule slightly and repeating these steps.

When you are finished withdrawing the contents from the ampule, discard the glass in an appropriate container.

**PROCEDURE**

**Withdrawing from vials**

1. Swab the rubber stopper with IPA and allow to dry.
2. Assemble the needle and syringe.
3. Pull the syringe plunger back to an amount equivalent to the volume you need to withdraw.
4. Place the tip of the needle on the rubber stopper at a 45 degree angle.
5. As you begin to enter the vial, turn the needle up to a 90 degree angle and continue into the rubber stopper.
6. Inject the air from the syringe into the vial.
7. Invert the syringe and vial 180 degree in a clockwise motion.
8. Withdraw the appropriate volume from the vial.
9. Make sure the syringe and needle are free of air bubbles.
10. Invert the syringe and vial back to the starting position.
11. Withdraw the needle from the rubber stopper.
CHAPTER 4 • Delivery Systems Equipment

SPECIAL EQUIPMENT FOR STERILE COMPOUNDING

Now you know all about the supplies used in the preparation, storage, and delivery of sterile products. But, you might recall from Chapter 2 that there is special equipment to assist you in making sure these products are made in a sterile setting.

The USP requires that you prepare CSPs in an ISO Class 5 clean air environment. Class numbers are used to describe air quality in a designated area. See Table 4-1 from USP 797.

This type of clean air space is provided by powerful filters and three important pieces of equipment:

- a laminar airflow workbench (LAFW)
- a biological safety cabinet (BSC)
- a compounding aseptic isolator (CAI)

High-Efficiency Particulate Air Filtration

In order to satisfy the USP’s guidelines for ISO Class 5 environments, high-efficiency particulate air filters, or HEPA filters, are used in all aseptic processing areas. These filters extract any particles larger than 0.5 microns. The filters must be tested and certified every six months.

Laminar Airflow Workbench

Most CSPs are compounded in a laminar airflow workbench (LAFW). The LAFW, also called a horizontal laminar flow hood, is a work area that prefilters large contaminants from the workspace and then uses HEPA-filtered air in a horizontal flow to extract smaller particles (Fig. 4-4). This creates an aseptic work area.

Here’s how the LAFW works:

1. Regular room air is pulled through a vent in front or on top of the hood by a standard furnace filter.
2. The air is pushed toward the back of the LAFW.
3. The air passes through a HEPA filter.
4. The HEPA-filtered air is then forced over the work area at 90 ft/min, which effectively sweeps particulate matter away from the product you are compounding.

Notice that in a LAFW the HEPA-filtered air is blowing directly at you. Anything that you spray while preparing your CSP will blow onto you, which is why hazardous drugs are not prepared in this type of hood.

Biological Safety Cabinet

Unlike the LAFW described above, some hoods blow HEPA-filtered air vertically downward through a top hood and into grills located along the front and back edges of the work surface area. This kind of vertical flow hood is known as a biological safety cabinet (BSC).

These types of hoods can be used for any product preparation, but you’re required to use a BSC when working with hazardous compounds such as products used in chemotherapy treatment.

BSCs also have a clear glass or plastic shield that extends partially down the front of the hood. This shield and the vertical flow of air protect you from contamination by drugs processed within.

Compounding Aseptic Isolator

A compounding aseptic isolator is a LAFW that is completely enclosed. You can only access the work surface through glove box-type openings. Materials and supplies for aseptic processing enter through special airlock boxes attached to the unit. As with LAFWs and BSCs, this device also uses a HEPA filter system.

Cleaning the Hood

Though you can’t see it, some contamination is expected to be present on all types of flow hoods—especially
between product preparations. Therefore, it is critically important to follow a standard procedure for cleaning airflow hoods. Proper cleaning will reduce the risk of cross-contamination of products.

**CHAPTER HIGHLIGHTS**

- The different parts of a syringe are the tip, rubber plunger tip, barrel, flange, plunger, and flat knob.
- Syringes are made of glass, plastic, and/or metal, and they are used for injection, irrigation, withdrawal of fluids, or other parenteral delivery.
- General use syringes come in various sizes and can be used for large or small amounts of fluid.

- Syringes commonly used are the luer-lock and the slip-tip syringe.
- Small syringes, such as insulin syringes and tuberculin syringes, are used to give injections just beneath the skin. An insulin syringe is marked in units, for measuring insulin. A tuberculin syringe is marked in milliliters up to 1 mL per syringe. Larger syringes can be calibrated in increments of 1.0 mL, 0.1 mL, or 0.2 mL.
- The gauge of the needle is the diameter of the opening of the needle. Most commonly, needle length may be anywhere from 3/8 inches to 3½ inches.
- The different parts of the needle are the bevel, bevel tip, bevel heel, shaft, and hub.
- Different types of needles include filter needles, filter straws, and vented needles.
- A filter needle is used to extract glass shards from an ampule.
- A filter straw is used to withdraw a single dose of fluid from an ampule.
- A vented needle is used for reconstituting a powdered medication.
- Large-volume parenterals consist of IV bags or bottles of 500 mL or more. Piggybacks consist of IV bags with volumes up to 250 mL.
- Glass IV bottles are more transparent than plastic bags and cannot be poked or pierced. Plastic IV bags take up less space, are less expensive, and lighter.
- Vials are convenient CSP containers. They have a rubber stopper, which is pierced by the needle when drawing up specific amounts of fluid.
- Ampules have glass necks that are snapped off before fluid is drawn.
- There is a risk of rubber contamination when using vials and of glass shard contaminations when using ampules.
- HEPA filtration is a powerful filter system used in all CSP workbench spaces. The HEPA filtration system complies with the USP’s requirements for an ISO Class 5 environment.
- Laminar airflow workbenches, biological safety cabinets, and compounding aseptic isolators are all used for CSP preparation.
- Laminar airflow workbenches (LAFWs) provide a horizontal airflow within the work space.
- Biological safety cabinets (BSCs) provide a vertical airflow within the workspace.
- Compounding aseptic isolators provide HEPA-filtered air that is completely enclosed.
- Flow hoods should be cleaned regularly and documented. A standard procedure must be followed to avoid contamination.
QUICK QUIZ

Answer the following multiple-choice questions.

1. A filter straw is used to
   a. extract fluids from a vial.
   b. reconstitute a powder.
   c. dilute a solution.
   d. extract shards of glass from an ampule.

2. Which part of the syringe should not be touched?
   a. the barrel
   b. the lip
   c. collar
   d. the plunger

3. A vertical flow hood is also known as a
   a. aseptic isolator.
   b. ISO Class 5 environment
   c. laminar airflow workbench.
   d. biological safety cabinet.

4. A tuberculin syringe is used for all of the following EXCEPT:
   a. pediatric doses.
   b. skin testing.
   c. an insulin injection.
   d. an injection just below the skin.

5. The greatest risk of contamination when using an ampule is from
   a. bits of rubber.
   b. glass shards.
   c. particles of fiber.
   d. flakes of skin.

Please answer each of the following questions in one to three sentences.

1. What are the calibrations on a syringe? What are they used for?

2. Describe how the gauge of a needle is measured. Why would a certain gauge be used instead of another?


4. Explain the differences between a luer-lock syringe and a luer-slip syringe.

5. Describe some of the characteristics of the large-volume IV and IV piggybacks. What is the relationship between the two?

Label the following statements as either true or false.

1. _____ A filter needle is used to reconstitute a powder medication.

2. _____ The larger the gauge of a needle, the smaller the opening.

3. _____ A large-volume IV bag contains 500 mL or more of fluid.

4. _____ The surfaces of a LAFW should always be wiped from front to back.

5. _____ HEPA stands for high-efficiency particulate air.

Match the term in the left column with the correct description from the right column.

1. gauge  a. a tiny tube inserted into a vein
2. catheter b. a sealed glass container
3. ampule c. the size of the opening of a hypodermic needle
4. intravenous d. the slanted, pointed tip of a hypodermic needle
5. bevel  e. within a vein