

# Choosing the Right Centrifuge for Your Application

by Tammy Goodman

A centrifuge is a critical piece of equipment for the laboratory, and often a significant investment. Therefore, when the time comes to add a new centrifuge—or replace an old one—it is important to make an informed decision. There is a good chance that your needs have changed since the last time you purchased a centrifuge. For example, space may now be tighter, or the activity level of the laboratory may have increased substantially and there are now many more users. Perhaps you want to try a new protocol that you learned about at a recent conference.

With so many recent advances in both science and technology, it is wise to educate yourself about the wide range of centrifuge options now available. This will help you choose a model that will suit your needs not only today, but for many years to come.

Following are some key questions that can be used to determine the type of centrifuge that will best meet your needs:

1. What applications and protocols will the centrifuge be used to support?
2. What are the maximum and minimum *g*-force (relative centrifugal force, RCF) and volume requirements?
3. How many tubes or samples must be processed in a run, shift, or day?
4. What types of sample formats will the centrifuge need to support (i.e., microplates, blood collection tubes, disposable conical tubes)?
5. What type of rotors will be needed to support your applications (i.e., fixed angle, swinging bucket)?
6. How many people will be using the centrifuge?
7. Is versatility important? That is, do you anticipate the need for a broad range of protocols and multiple users, or will you be performing the same standardized protocol day after day?

8. Do you have any space restrictions, such as benchtop or floor space only?
9. Do you have special needs such as process traceability, user lock-out, or biocontainment?
10. What is your budget?

Once you have answered these questions, you should have a better picture of your centrifuge requirements. It is also helpful to review the basic types of centrifuges to make sure you know which category best fits your needs.

## Floor model or benchtop?

Centrifuges are generally classified as either floor-standing or benchtop models. Within each category are several platforms from which to choose. The style you choose is typically determined by performance requirements, available space, and budget.

Floor-model centrifuges free up bench space and are often chosen for either high-speed or high-capacity sample processing. Within the floor-model category there are superspeed centrifuges, ultracentrifuges, and low-speed centrifuges.

Benchtop centrifuges offer versatility and convenience, and can be equipped many ways to accommodate a broad range of needs, making them a cost-effective solution for many laboratories. Benchtop platforms include general-purpose centrifuges, microcentrifuges, small clinical centrifuges, cell washers, and high-speed models.

## Choosing the right floor-model centrifuge

### Superspeed centrifuges

If you are looking for high capacity, high *g*-force, and versatility, a superspeed centrifuge (Figure 1) is probably the best choice. Many superspeed



Figure 1 Superspeed centrifuges are an excellent choice for multiuser, multiprotocol environments, offering high capacity, high *g*-forces, and a broad range of rotors and accessories.

models offer a choice of up to 40 rotors, making them an excellent solution for core laboratories performing general preparative applications such as whole cell separations, protein precipitation, tissue culture, subcellular isolation (i.e., Golgi bodies, ribosomes), plasmid preps, and DNA/RNA separations.

Superspeed centrifuges are also the best option for multiuser, multiprotocol environments. Their versatility enables researchers to step into new, cutting-edge technologies without purchasing a dedicated centrifuge for one specific application. The maximum RCF on a typical superspeed centrifuge is  $70,450 \times g$ , with a volume range of 1.5 mL–1000 mL.

### Ultracentrifuges

If your application calls for *g*-forces of up to  $1,000,000 \times g$ , you will need an



**Figure 2** General-purpose benchtop centrifuges offer versatility and convenience, and can be equipped many ways to support tissue culture, DNA/RNA research, cell harvesting, subcellular separations, and many other applications.

ultracentrifuge. These extremely powerful floor-model centrifuges support sample volumes ranging from 0.23 mL to 250 mL. Within the ultracentrifuge line there are two platforms: full-size floor models, which support  $g$ -forces of up to  $802,000 \times g$  and volumes up to 250 mL; and microultracentrifuges, which support  $g$ -forces of above  $1,000,000 \times g$  and microvolume samples up to 13.5 mL.

Common ultracentrifuge applications include the separation of virus particles; DNA, protein, or RNA fractionation; as well as lipoprotein flotation. Density and size gradient separations are also regularly performed in ultracentrifuges and, more recently, a number of new nanotechnology applications have appeared.

### Low-speed centrifuges

These large-capacity centrifuges have fairly specific applications due to the maximum RCF of approximately  $7000 \times g$  (note: the maximum  $g$ -force varies slightly depending on rotor and unit). The most common low-speed application is the separation of whole cells, for example, separating red blood cells and platelets from whole blood. The second most common application is the whole cell harvest step in the processing of large volumes of cultures from bioreactors in the bioprocessing and pharmaceutical industries.

Low-speed centrifuges offer a basic set of rotors that support volumes ranging from 1.5 mL (with the use of adapters) up to 2000 mL. These units can

also be equipped with specially designed rotors and liners for the blood banking industry.

## Choosing the right benchtop centrifuge

Whether you are looking for something versatile that your laboratory can grow into, or a dedicated centrifuge for specific protocols, there is a benchtop centrifuge to meet those needs. Benchtop centrifuges are available in a wide variety of platforms designed for different application requirements, including general-purpose benchtops, microcentrifuges, small clinical centrifuges, cell washers, and high-speed benchtop centrifuges.

### General-purpose benchtop centrifuges

These workhorse units (*Figure 2*) are the most common type of centrifuge found in the laboratory. Their versatility makes them extremely practical: They offer a wide range of rotor types, volumes, and speeds within a single unit to meet the demands of many common protocols. General-purpose centrifuges are typically used for tissue culture, DNA/RNA research, cell harvesting, subcellular separations, protein work, and many other applications. Some general-purpose benchtops offer RCFs of up to  $24,000 \times g$ ; typical volume ranges are 0.2 mL–750 mL. Most general-purpose units can be equipped with a broad range of swinging-bucket and fixed-angle rotors, making them an excellent fit in a multiuser environment where floor space is an issue and RCFs of up to  $24,000 \times g$  are sufficient.

### Microcentrifuges

Like the general-purpose benchtop models, microcentrifuges (*Figure 3*) are a necessity in every laboratory. These compact units provide RCFs of up to approximately  $21,000 \times g$ , which is sufficient for the most common microvolume applications such as plasmid, DNA and RNA work, and mini-

prep kits. Designed to spin up to 2-mL volumes, microcentrifuges are typically equipped with rotors that accept commonly used 0.2-mL PCR tubes and 1.5-mL/2.0-mL disposable microcentrifuge tubes and filters.

### Clinical benchtop centrifuges

These compact models are designed for use in hospitals and clinics that require a low-throughput unit to spin blood collection tubes and urine samples at very low speeds for diagnostic examination. Most of these centrifuges spin at RCFs at or below  $3000 \times g$ . The volume supported by a typical clinical benchtop unit ranges from 3-mL up to 15-mL tubes, with throughput ranging from 4 to 28 tubes per run, depending on the tube size and unit selected.

### Cell washers

These special-purpose centrifuges support very specific applications in the clinical and medical industry: washing away cellular debris, extraneous proteins, and other constituents of donor blood from red blood cells. The washed red blood cells are used for tests such as cross-matching prior to blood transfusion. Cell washers spin at RCFs at or below  $1500 \times g$  and support 3-mL and 5-mL culture tubes.

### High-speed benchtop centrifuges

These powerful and compact units offer  $g$ -forces close to that of a floor-model superspeed centrifuge, but with



**Figure 3** Microcentrifuges are a necessity in every laboratory for everyday microvolume applications such as plasmid, DNA and RNA work, and miniprep kits.

a limited set of rotors. The most common rotors and applications for this type of centrifuge include a low-speed, high-volume swing-out rotor for a whole cell harvest step; a high-speed, midvolume (i.e., 50–15 mL) fixed-angle rotor for a subcellular pelleting step; or a high-speed, low-volume (1.5-mL/2.0-mL) fixed-angle rotor for certain DNA/RNA applications. The average maximum RCF for a high-speed benchtop is 50,000 × g, with a volume range from 1.5 mL to 200 mL over a range of swinging-bucket and fixed-angle rotors.

## **A long-term investment**

Understanding the different types of centrifuge platforms and the applications they support is a good first step in the selection process. Once you have identified your application needs and the appropriate centrifuge model, your centrifuge supplier should be able to assist you in configuring the best system (centrifuge, rotor, and consumables) to meet your specific requirements.

Performing a thorough assessment of your current and future centrifuge

application needs and doing some up-front research will optimize your centrifuge purchase and ensure that it provides a long-term investment that will support your research for many years to come.

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