

Centrifuges

2021 Resource Guide





Centrifuges—essential instruments for biology and chemistry laboratories—vary in speed, size and rotor capacity based on application.



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Types of Centrifuges

Centrifuges are essential instruments used in biology and chemistry laboratories for isolating and separating components of complex biochemical structures. They vary in speed, size and rotor capacity based on application.

We can group them into following categories:

- Mini and micro centrifuges
- Clinical centrifuges
- Multipurpose high-speed centrifuges
- Ultra centrifuges

MINI AND MICRO CENTRIFUGES

Mainly used for quick separation of small samples (volumes of 2.0 mL or less) at high speeds. Their applications include microfiltration, cell separation, nucleic acid and protein pelleting. The compact design and small footprint make these ideal for benchtops and laboratories with limited space. These centrifuges feature a speed change from 1,000 *g*-force (mini) to more than 20,000 *g*-force (micro). They have 6-, 8-, 12-, 18-, 24- and 36-place rotors, and the size of the sample tubes varies based on this number.





CLINICAL CENTRIFUGES

These moderate-speed centrifuges are used for the separation of blood, plasma, sera, urea as well as other routine applications in clinical laboratories, medical centers and hospitals. With a variety of sizes, such as mini, small, medium and large, benchtop and large floor models are available for your particular space and application. The rotors can accommodate 1.5-mL to 50-mL sample tubes, microplates and 10-mL syringes. High-capacity buckets can handle up to 196 x 5/7 mL blood tubes.

MULTIPURPOSE HIGH-SPEED CENTRIFUGES

These high-speed centrifuges are designed for large volume laboratories with busy daily workloads. They have a variety of rotors for test tubes, bottles and tubes up to 80 x 15 mL. The high capacity makes them ideal for large laboratories in the field of cellular and molecular biology, for clinical protocols and in industrial applications. A large assortment of accessories, including buckets, and adaptors, supports diverse applications.



ULTRA CENTRIFUGES

These centrifuges are designed to work at very high speeds—ranging from 200,000 *g*-force to 1,000,000 *g*-force. Molecules are separated at a faster speed with a high resolution compared to other types of centrifuges. These are used in the fields of molecular biology, biochemistry and cell biology, and applications include the separation of viruses, proteins, lipoproteins, RN, and plasmid DNA. There are two types of ultra centrifuges—analytical and preparative.



Centrifuge Tubes and Rotors

TUBES

Centrifuge test tubes vary based on material, size and shape. Glass centrifuge tubes are more expensive than plastic, but they withstand most solvents. They need to be handled with extreme care—even a small scratch affects their durability under strong centrifugal force. On the other hand, plastic centrifuge tubes are less expensive with comparable durability to glass. Microcentrifuge tubes, used for very small volumes, are made of disposable plastic. For large samples—volumes from 250 to 1000 mL—centrifuge bottles are used. They are usually made of plastic, but some are made of heavy glass. Centrifuge tubes are available in different shapes—conical, round bottom or flat bottom—to fit various rotor types. Conical tubes are only used in an insert that is designed to hold them securely while the centrifuge is running.





ROTORS

The types of rotors used for centrifuges can be grouped into three categories:

1. **Fixed-Angle Rotor:** These hold sample tubes at a constant angle to the axis of rotation. Even though the angle varies based on the rotor, the most common angles are between 20–45°. Fixed-angle rotors are good for the pelleting of particles. Particles sediment faster in a fixed-angle rotor compared to horizontal rotors. The main drawback of a fixed-angle rotor is that particles will form partly on the side wall of the tube, making the collection of a loose pellet difficult. Main applications for the fixed-angle rotor include pelleting bacteria and cells as well as isopycnic separation of macromolecules, such as DNA, RNA and proteins.
2. **Swinging Bucket (Horizontal) Rotor:** This type of rotor has buckets to hold the sample tubes. The sample tubes are placed vertically into individual buckets before starting. After starting, the tubes move to a horizontal position due to the effect of the centrifugal force. When finished, the particles sediment evenly on the bottom of the tube. Horizontal spinning is highly effective for the separation of solutions with larger particles at low speeds. The swinging bucket rotor is not ideal for pelleting. These rotors also need to be cleaned and greased periodically to maintain smooth rotation and balance.
3. **Vertical-Angle Rotors:** These rotors hold sample tubes in a vertical position when the centrifuge is operating. In this type of rotor, the run time is short, so the particle has a short distance to travel to pellet. Applications for vertical-angle rotors are quite unique, ideal for isopycnic separations, like banding of DNA in cesium chloride and gradient/density separations such as viral particles. These rotors are not used for pelleting.



Proper Care and Safety

To maintain fast acceleration, consistent speed and reliable performance, centrifuges require proper use and regular care. Follow these simple tips to ensure dependable operation and extend the life of these delicate instruments.

1. PROPER USE

- Since centrifuges spin samples at such high speeds, it is important to place the unit on a flat, level and stable surface that can support the weight.
- Select the right rotor with the desired speed. Ensure that the rotor is securely placed in the centrifuge. Use the correct size and shape of tubes for the rotor or insert.
- Always balance centrifuge tubes in the rotor before starting. Balancing is extremely important at higher centrifugation speeds. Balance the tubes by position and mass. Tubes of the same mass should be 180° opposite each other. If you only have one tube, prepare another tube with the same mass of water and place it in the opposite hole containing your sample in the rotor.
- When the centrifuge starts, observe it to verify that it reaches the desired speed and works properly. If it shakes, moves or makes noises, turn it off and unplug the power immediately to inspect the centrifuge. If the issue is not resolved, contact the manufacturer.
- Use appropriate personal protective equipment (PPE) when working with or near centrifuges. This includes safety goggles or glasses, gloves, a lab coat and closed-toe shoes.
- Before taking your samples out, wait until the centrifuge is completely off and the rotor stops spinning (rotor will spin for a while even though the centrifuge has stopped).
- When biohazardous chemicals are used, load and unload the rotors inside the biosafety cabinet. Use gasketed safety tubes with biohazardous materials.



2. CLEANING, INSPECTION AND LUBRICATION

- Check the centrifuge before use to make sure that the inside is clean and free of dirt, dust and spills. After each use, wipe down the inside of the centrifuge, rotor chamber and other accessories with a soft, moist cloth and mild cleaning solution, such as 70% ethanol. Wait until it is completely dry before closing the lid.
- When biohazardous chemicals are used, specific cleaning agents or autoclaving is recommended. Radioactive decontamination is needed when working with radioactive isotopes.
- Periodically inspect the essential centrifuge parts, such as O-rings and gaskets, to ensure that they are clean and not damaged. Lubricating parts of your centrifuge is very important. O-rings, buckets and drive shafts must be kept lubricated to prevent leaks and malfunctions. Evenly lubricate these parts periodically using the manufacturer's suggested lubricant. Check the rotor for scratches and wear. Also check the tubes for cracks since they may cause spills and imbalanced operation.

3. MAINTENANCE AND SERVICE AGREEMENT

- It is beneficial to keep a maintenance log book of cleaning, repairs and services done on the centrifuge. Getting a service agreement is recommended as it will cover a variety of things, such as preventive maintenance and inspection services. Keeping a copy of the service agreement handy will help in case of malfunctions and issues.



Frequently Asked Questions

1. Do I need a refrigerated centrifuge?

It depends on your samples and the application. If your samples, such as proteins, are sensitive to high temperatures, a refrigerated centrifuge will be the best choice.

2. What are the most important factors to consider in buying a centrifuge?

Following is a list of factors to consider—the list may vary based on your needs and the type of centrifuge you are considering.

- Reliability
- Durability
- Accuracy/precision
- Ease of use
- Price
- Low maintenance/operating costs
- Safety
- Warranty/service and support
- Noise

3. What is the maximum speed to which a centrifuge can accelerate?

There are a variety of centrifuges with speeds starting from a few thousand revolutions per minute (RPM) and going up to 30,000 RPM.

4. Centrifuge speed is sometimes expressed as “x g” and sometimes as “RPM.” Which one should I use?

x g is the unit of Relative Centrifugal Force (RCF) and means gravity. If you want to be exact, use RCF (“x g”), which includes both the rotor radius and the speed of the centrifuge in RPM. You can convert “RPM” to “x g” using the equation $g = 0.00001118 \times R \times S^2$, where R is rotor radius in centimeters and S is the speed in RPM.

5. I made a mistake balancing my tubes, but the centrifuge works fine. Should I stop the centrifuge?

Always balance the centrifuge tubes in the rotor. Unbalanced tubes cause serious damage to the rotor and centrifuge. Stop the centrifuge and rebalance your tubes immediately.

6. Are the centrifuge rotors autoclavable?

It depends the type of the centrifuge. Some rotors are fully autoclavable at 120 °C whereas others are not. Check the manufacturer’s manual for details.

7. If there is a power failure while centrifuge is running, can I open the lid?

In the event that power fails while the centrifuge is operating, there are different ways to open the lid depending on the centrifuge. Check the manufacturer’s manual for details.

8. Should I replace an old centrifuge or just repair it?

It depends on the age of the centrifuge, the condition of the centrifuge and the usage and maintenance performed on it. If it is more than 20–30 years old and it has not been maintained well, it may not be safe to use.

9. Can I monitor my centrifuge remotely?

With advanced technology, some manufacturers have started to provide apps that allow users to monitor their centrifuges remotely.



