1. Introduction

Centrifuges are instruments used to separate mixtures based on particle size and density by spinning the mixtures at high speeds. If used or maintained improperly, centrifuges have the potential to cause injury and potential exposures to biological hazards. A mechanical failure of the rotor can result in injury, even death; and sample container breakage can generate aerosols that can be harmful to inhale. Thus, it is very important to act safely when using and maintaining these instruments.

2. Scope

The purpose of this document is to assist laboratory supervisors in the implementation of safety practices for using and maintaining their centrifuges. This document does not take the place, nor does it fulfill the role of a detailed work-specific, safety focused Standard Operation Procedure (SOP). Before any personnel uses a centrifuge, they must have received in-house training and have reviewed their lab's specific centrifuge SOP. As with the operation of any equipment, the manufacturer's instructions on safe use and required maintenance should be followed.

3. Applicable Legislation

Canadian Biosafety Standard 3rd Edition (Nov 2022). 3.6.1 Essential Biosafety Equipment.

4. Responsibilities

4.1 Responsibilities of Directors, Department Heads and Managers

- Each has the following responsibilities under this standard operating procedure.
- Ensure that a written assessment of potential hazards has been completed for all areas under his/her authority.
- Ensure that this SOP is implemented in all facilities under his/her authority.
- Ensure that all pertinent supervisors, employees and students are aware of this SOP and have been informed of the proper use, care and maintenance of centrifuges.

4.2 Responsibilities of Supervisors

- Supervisors must be knowledgeable about the hazards in their area. They must:
- Ensure that all staff and students are aware of the hazards present and have been informed of the proper use, care and maintenance of lab coats.
- Create a written SOP for the safe operation of the centrifuge (and rotors)
- Ensure all users are trained in the safe operation and maintenance procedures of the centrifuge and rotors to be used

- Document all training
- Validate the competency of users while operating the machinery and provide refresher training when appropriate
- Supervise centrifuge use when/if necessary
- Ensure that copies of the user instructions for the equipment are readily available
- Ensure that all routine maintenance and repairs are conducted as per instructions outlined in SOP

4.3 Responsibilities of Staff and Students

- Complete a training session on centrifuge (and rotor) use and maintenance
- Read and follow all provided instructions (SOPs) for the safe use and maintenance of the equipment
- Wear required PPE
- Operate and maintain all centrifuges and rotors according to the outlined safety procedure and lab protocol (SOP)
- Report any cause for concern or issues when operating the equipment to the responsible lab operator or supervisor
- Report any accidents (injuries, spills) or near-miss incidents to your supervisor immediately

5. Definitions

Centrifuges have typical characteristics based on their type and added features to match the needs of each laboratory. Look at the chart below for common characteristics for each type.

Typical Characteristics	**Categories of Centrifuges**			
	Microcentrifuge	Low Speed Centrifuge	High Speed Centrifuge	Ultracentrifuge
Sample Volume Size per tube/bottle	≤ 2.0 mL	1.5 mL - 200 mL	1.5 mL - 2000 mL	≤ 250 mL
RPM RCF = 11.2 x Radius of rotor (cm) x (RPM/1,000)2	≤ 26,000	2,000 - 8,000	14,000 - 24,000	35,000 - 150,000
Size	Small	Medium - Large	Medium - Very La	Medium - Very Large
Position	Bench Top	Bench or Floor	Bench or Floor	Bench or Floor

Physical Hazard Potential	Low	Moderate	High	Very High

5.1 Centrifuges components

- Centrifuge chamber – the inside of the centrifuge where the rotor is contained.
- Centrifuge lid – a door that closes the centrifuge chamber and includes a lock system that latches while the rotor is spinning and unlatches when the rotor has stopped spinning. This helps prevent injuries.
- Control panel – usually located on the front of the centrifuge for easy visibility and access.
- O-rings – ring shaped gaskets used to seal connections. These can prevent aerosol release when maintained properly.
- Rotor – fixed angle vessel or swim arm attached to the spindle that spins/rotate the samples.
- Rotor lid – a lid used primarily to close fixed-angle rotors.
- Sealed Rotors – create a seal between the rotor lid and rotor base for aerosol containment.
- Spindle anchors and rotates the rotor within the centrifuge chamber.
- Motor – drives the rotation of the rotor.
- Poser switch – turns the centrifuge on and off.

Safety caps/cups – caps or cups used to enclose swing arm rotor buckets or microplate holders for aerosol containment.

5.2 Centrifuges hazards

Hazards associated with centrifuging include physical hazards (such as lifting, electrical shock, explosion and noise) and the creation and release of aerosols. Centrifuge incidents can result in worker injury or illness, damaged equipment and damage to laboratory facilities.

Aerosolization - Aerosols are very small liquid droplets or particles that can remain suspended in air and may be inhaled depending on their size. Aerosols can be created when filling centrifuge tubes, removing plugs or caps from tubes after centrifuging, pipetting off supernatant, resuspending sedimented pellets, and during the process of centrifugation itself[3].

Aerosols from biological, chemical or radioactive materials can be harmful if inhaled. They can be released into the centrifuge chamber or rotor when force is exerted on tubes, vials, or microplates, or when they are broken or damaged during centrifugation. Without proper containment, aerosols can be released into the laboratory environment if a centrifuge is opened before aerosols are allowed to settle.

Physical Hazards

Explosions

- Incorrect tubes, unbalanced rotors and rotor failure can cause explosions.

- Rotors, especially those used in ultracentrifuges at high speed, are prone to metal fatigue over time. They can become cracked, distorted or corroded[1].
- Certain chemicals allowed to remain in the rotor from leaking samples or used to clean the rotor can also cause corrosion.[3]

Noise

- You can sustain hearing loss with constant exposure to excessive noise levels over time.
- A high speed refrigerated centrifuge generates noise levels as high as 65 decibels (dBA).
- OSHA has set the "Action" level for enrolling in a hearing conservation program at an average of 85 dBA over an 8-hour workday.

6. Safety precautions

- Do not operate any centrifuge if you have not been properly trained in the laboratory specific procedure.
- Install centrifuges according to manufacturer instructions and always away from flammable and or combustible materials.
- Use only rotors specifically designed for your instrument. For ultra centrifuges, the classification decal on the centrifuge and rotor should match.
- When working in the lab, wear PPE in accordance with the highest risk or possible hazard for the equipment, biological agents, material, or chemical used in the procedure.
- Check the Safety Data Sheet(s) (SDSs) for the chemicals that will be used in the procedure, to ascertain if any additional PPE is required. Centrifuge usage may require specific and additional PPE which must be detailed in your SOP (based on your LRA).
- When centrifuging hazardous materials classified as RG2 and RG2+, use tightly capped tubes and/or sealed safety cups or rotors that can be loaded and unloaded in a Biological Safety Cabinet (BSC) or fume hood depending on the hazard.
- The centrifuge must be carefully balanced before loading. An unbalanced load may present a risk to both the machine and to persons nearby. If the centrifuge begins to shake or wobble, it is off balance, and you should stop it immediately. The rotor should contain an even number of tubes. When working with an odd number of sample tubes use a balance or blank tube of the same weight as the opposing tube. Opposing tubes must be located 180 degrees from each other to achieve balance. If the liquid you would like to run has a higher or lower density than the balance tube, you must balance the tubes by mass or weight, not volume. The mass of the tubes should be as close as possible to run the centrifuge safely

A) Rotor properly balanced

b) Unbalanced rotors

- Tubes that are appropriate for the speeds and rotors of that particular centrifuge must be utilized.
- Centrifuge rotors should never be touched while the rotor is spinning, as they present a significant personal risk when in motion.
- Sample containers such as ultracentrifuge tubes and conical vials, should be made of plastics that can withstand the force exerted on them without breaking or leaking. They should be specifically designed for use in a centrifuge.
- Glass containers should be avoided.
- Sample containers should not be re-used for centrifuging.

7. Work practices.

7.1 Centrifugation of Biohazardous materials

1. Prepare samples in the appropriate centrifuge tube according to the manufacture specifications. If working with RG2+ biohazards, ensure they are prepared and loaded into a sealed safety cup inside a BSC.
2. If primary centrifuge tubes are aerosol tight (i.e., have O-rings), safety cups are not required
3. Examine O-rings before use for damage (e.g., cracks, deformities) and replace if needed
4. Ensure that tubes are balanced and not over-filled
5. Disinfect sample tube or safety cup exteriors before removing from the BSC or load inside the BSC
6. Load centrifuge tubes into aerosol-tight safety cups or an aerosol-tight rotor and securely fasten the lid.
7. Ensure rotor is properly balanced.
8. Perform the centrifugation run according to your program,

9. Stop the centrifuge immediately if you notice any unusual noises or shaking. Proceed to the emergency response section.
10. Check for leaks or spills after the centrifuge comes to a complete stop.
11. Remove the safety cups or rotor from the centrifuge without breaking the aerosol-tight seal.
12. Transfer the aerosol-tight container to the biosafety cabinet.
13. Remove samples from the safety cup or rotor.
14. Disinfect the interior and exterior of the safety cup/rotor using a suitable disinfectant.
15. Document regular disinfection of centrifuges in the Housekeeping and Decontamination Log
16. Disinfect centrifuges before repair or maintenance activities, and document maintenance in the Equipment Maintenance Log (see section 7.3)

7.2 In the event of centrifuge damage or failure:

1. Turn off centrifuge and disconnect it from the power source
2. Notify others in laboratory.
3. Notify the lab supervisor and safety officer
4. If you are unable to abort the run, leave the area and post signage that the area is off limits so no one else enters the room.

7.3 In the event there is a spill or release:

1. If you suspect that there has been a spill or aerosol release, or you open the centrifuge and notice a spill or compromised sample container:
2. Close the centrifuge lid and turn it off.
3. Notify everyone in the area and your supervisor.
4. Leave the lab, closing the door behind you.
5. Post a spill sign on door. If biohazardous, use a biohazard sign preferably specific to the biohazard if possible.
6. Report the incident to the safety office and initiate any agent-specific post-exposure response protocols if applicable.
7. Leave for 30 minutes to allow aerosols to settle.
8. For spills, clean up the spill wearing appropriate PPE.
9. Clean and decontaminate centrifuge interior, rotors, safety cups or buckets following your laboratory-specific SOPs.
10. Place any contaminated PPE and all clean-up materials in a biohazard bag.
11. Wash hands and any exposed skin surfaces with soap and water.

7.4 In the event of an exposure or suspected exposure:

1. Follow your laboratory-specific SOPs or incident flow chart for exposures. This will have lab-specific information on how to handle the incident.
2. Notify everyone in the area and your supervisor.
3. Seek medical attention

4. After treatment, an incident report may be required to document any injury, illness or exposure, and signed by your supervisor.

7.5 Cleaning a spill within a Closed Cup, Bucket, or Rotor

1. Wait for one hour before opening the centrifuge in case containment has been breached. Put on lab coat, gloves, and proper eye protection prior to opening centrifuge. Open carefully to assess the damage:
2. Prepare the disinfectant and place supplies inside the biosafety cabinet (BSC).
3. If the spill is contained within a carrier (i.e. closed cup, bucket, or rotor) spray the exterior with disinfectant and allow the required amount of contact time for surface decontamination. Remove the carrier to the BSC.
4. Open the centrifuge rotor or bucket inside of the BSC. Use a mechanical device (forceps, tongs, etc.) to remove broken glass and place directly into sharps container. Carefully remove any unbroken tubes. Wipe tubes and carrier/bucket with disinfectant.
5. After disinfection, carrier, bucket, or rotor must be washed with a mild soap and water.
6. Spray the interior of the centrifuge chamber with disinfectant and then wipe down with soap and water.
7. Dispose of all clean-up materials (except sharps) in an appropriate biohazardous waste container. Dispose of sharps in a biohazard sharps container.
8. Remove PPE, discard disposable PPE as biohazardous waste and wash hands.
9. Complete cleaning and disinfection logbook detailing the incident, date and time.

7.6 Centrifuge regular maintenance.

Establish a basic routine maintenance schedule for each centrifuge and rotor based on manufacturer recommendations. A maintenance schedule can include:

A) Inspecting for damage or defects such as:
   - Frayed power cord
   - Improperly latching lid
   - Missing O-ring
   - Dry, cracked seals, gaskets, or O-rings
   - Rotor cracks, scratches or dents
   - Rotor corrosion or pitting

B) Applying grease to the seals using the manufacturer's recommendations.

C) Periodic cleaning/disinfecting

Maintain a logbook for all high speed and ultracentrifuges to include:

A) Operator, date, and time
B) Rotor type and serial number

C) Run time and temperature
D) Speed (g-force or RPM)

8. Training requirements

- Read this SOP and any lab-specific training related to centrifuge use
- Each lab (or dept) must provide in-house training on centrifuge use and cleaning to all staff/students who will be using the equipment
- Biosafety Level 1, Biosafety Level 1 & 2 or the Blood Borne Pathogens quiz for work with Level 1/2/2+ material

9. References

– Fundamentals of Centrifuge Safety
– Safe-Work-Practices-Centrifuge-Use.pdf (utoronto.ca)
– SOP - Centrifuge Safety - Bridges Lab Protocols (umich.edu)
– UBCV-RMS-OHS-SOP-14-002-Centrifuge-Safety.pdf
– centrifugation_2-2-21.docx (live.com)

10. Revision History

Date	Revised by	Changes
May 2025	Raico Lamela Natalie Roy	New procedure

11. Appendix

Centrifuge Use & Maintenance Log

The centrifuge use & maintenance log can be edited to suit your needs. It was designed to work in shared spaces as well.

Name	PI & Room number	Speed/ rotor used	Sample type	Cleaned after use