

Laboratory Ergonomics: Microtomes, cryostats, cell counters, glove boxes, micro-manipulation, and lifting

By Tamara Mitchell



Microtomes

Manual rotary microtomes require many repetitive functions. A lab technician using 40-50 blocks a day will turn the microtome wheel at least 1000 times. This is not only repetitive, but requires force as well. Other related tasks such as replacement of specimens and use of a trimming wheel add to the problem.¹ Problems that may appear only after years of use include wrist and shoulder problems, back pain, and sciatica (aching/tingling in the leg). In order to reduce the stresses and repetitive nature of this work, consider the following options:^{1,2,3}



Photo courtesy of LeicaBiosystems.com

- The course-feed wheel should be positioned close to the user.
- Use the entire arm to rotate the hand wheel and keep the arms close to the body.
- Use a fully adjustable chair with adequate back support and a footrest.
- Adjust the chair height and back
- Place the microtome on an appropriate height work bench for standing or sitting. Refer to our first article on Laboratory Risk Factors for workstation height guidelines. http://working-well.org/articles/pdf/Lab_Ergo.pdf.
- Raise or lower the work surface with the microtome to make sure that the wrist is not bent and shoulder thrust is minimized.
- If sitting, make sure there is adequate clearance for legs and thighs.
- Rotate tasks and take frequent short breaks every 20 minutes including getting up from the chair and walking around, doing stretches and shoulder rolls.
- Reduce force when operating the handwheel.
- Apply padding to the work surface and edge to eliminate sharp edges. Inexpensive foam child protection strips are readily available online, or if disability is an issue, tape bubble wrap on the edges of surfaces to provide cushioning for forearms.
- Purchase an automatic microtome when feasible.



Cryostats¹

- If you are sitting, use a fully adjustable chair with adequate back support and a footrest.
- Apply padding to the edge of the cryostat to reduce contact stress.
- Take short stretch breaks every 20 minutes.
- Avoid placing utensils such as forceps inside the cryostat. This will keep utensils at room temperature and reduce cold exposure to the hands and fingers.



Illustration courtesy of LeicaBiosystems

Cell Counters^{1,5}

- If possible, switch to automated cell counting rather than manual cell counting.
- Use an edge protector and/or wrist rest to reduce stress on forearm and wrist. Reduce the force needed to strike the manual counter.
- Take frequent, short breaks.
- Rotate tasks among several people.
- Use an adjustable chair or stool with solid footrest.
- Purchase an electronic differential tally counter to replace manual counters. Soft keys permit accurate and fast counting with decreased hand fatigue. Or purchase a "light touch" manual counter.



Automated Cell Counter

Photo courtesy of ThermoFisher Scientific



Electronic Differential Tally Counter

Photo courtesy of Daigger Lab Equipment

Flow Cytometers¹

The use of a flow cytometer requires frequent lateral bending, neck and back flexion, and arm extension. This is due to the receiving port being located on the bottom of the flow cytometer. The operator must sit in awkward positions to see the controls. Implement the following recommendations to control hazards associated with flow cytometer use:

- Raise the flow cytometer by placing a block between it and the workbench.



Photo courtesy of ThermoFisher Scientific

- Purchase an electric or hydraulic adjustable table so that each lab technician will be able to adjust the height most comfortably for them. There are bases that can be retrofitted to any work surface that will allow easy, automated height adjustment. Please refer to our web page on worksurfaces to see the various options. <http://working-well.org/Website/pwksfc.html>
- Use a fully adjustable chair or stool with footrest.
- Position the VDT display so the top of the screen is approximately at eye level.

Glove Boxes^{1,4, 6}

Working in glove boxes or anaerobic chambers requires working with extended arms and frequent side reaching, both very tiring for the lower back, shoulders and upper arms.^{4,6} The thick gloves force the user to grip objects more firmly. Where possible, the following are recommended to control ergonomic hazards:

- If possible, place the glove box on an automated height-adjustable work surface to enable easy height adjustment of the glove box openings for each operator. If the glove ports are too high, the operator will need to raise the arms and shoulders in a static position that causes fatigue to these body parts, however if the ports are too low, a forward-leaning posture is required resulting in static tension and fatigue in the lower back and neck.⁴ Position the openings so that a relaxed, upright and neutral posture with the elbow and glove ports are in the same plane.^{4,6} This is very important when using the glove box, especially for extended periods of time.⁴

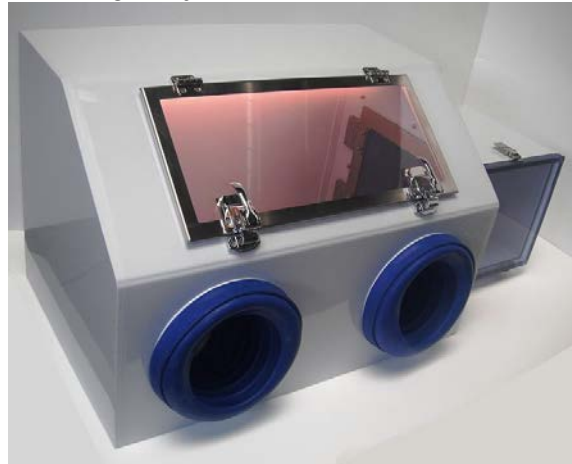


Photo courtesy of laboratory-supply.net

- If the type of glove box is not conducive to placing on a height adjustable work surface, the height of the operator needs to be adjustable through an adjustable standing platform.
- Move all needed materials from the side chamber to the main chamber to reduce side reaching.
- Use highly absorbent hand powder or lightweight cotton gloves for glove comfort.
- Rotate tasks to avoid long continuous use of glove boxes.
- If seated, use a height-adjustable chair with adjustable backrest.



Photo courtesy of glovebox.co.kr

- Take frequent mini-breaks (3-5 minutes for every 20-30 minutes of glove box work) to perform stretching exercises and relieve strain from the shoulders and improve circulation to the shoulders, arms, and hands.
- Use anti-fatigue mats when using the glove box in a standing position as shown on our web page: <http://working-well.org/Website/plabsup.html#mats>

Micro-manipulation and fine motor skills^{1,5,7,8}

Many laboratory procedures require repetitive use of the finger and wrists. For example, removing caps and screw-off vials, reaching into bins, and using forceps all require use of small muscle groups that tire quickly or awkward postures that cause strains. Small dissections under a microscope require use of small tools and small muscles of the hands and arms.

- Use plastic vials with fewer threads to reduce twisting motion when capping and uncapping lids.
- Use low force forceps or reverse action forceps.⁷
- Use small pieces of foam tubing to prevent soreness on fingertips and to distribute the force over a greater surface area, reducing compressive forces on soft tissue. (See Resources below for foam tubing).



Forceps grip enlarged with foam tubing.

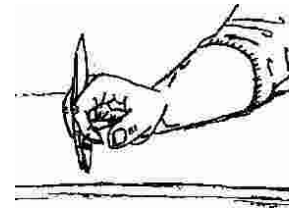
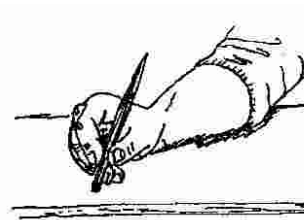
Courtesy of Reference 7.



Dissecting Needle grip enlarged with foam tubing

Courtesy of Reference 7.

- Alternate using forceps between the first and second fingers, and the thumb and first finger to reduce the use of the thumb. The thumb is used repeatedly in almost every lab task.



- Tilt storage bins toward you to reduce wrist flexion while reaching for supplies.
- Take short breaks and do hand, wrist, and forearm exercises. Refer to our web page on Stretches for good hand, wrist and forearm exercises: http://working-well.org/Website/st_arms.html
- Use pre-printed computer-generated labels to avoid labeling small test tubes and vials by hand.
- When writing in lab notebooks is required, use pens and pencils that fit your hand. Our web page on office supplies have many good suggestions: <http://working-well.org/Website/poffsup.html>
- A slantboard, and a padded edge protector really help when taking notes also. Please refer to our web page with document holders and slantboards: <http://working-well.org/Website/pdochldr.html>
- Modify tools that do not allow you to maintain straight wrists or require pinch gripping. See Reference 7 for excellent illustrated ideas on tool modification. Three rules for tool modification are:
 - 1) Build up the part of the tool that your hand holds to fit your hand better and to reduce a pinch grip.
 - 2) Change the angle of the handle so you can hold the tool with a straight wrist.
 - 3) Use non-slip materials to reduce the force needed to hold the tool in position.

- Share workload between the right and left hands.
- Choose the right tool for the job.
- Ensure tools are in proper working order.

Lifting

*Centrifuge rotors.*¹ Centrifuge rotors can weight up to 35 lbs. and are awkward in shape, posing the risk of strains during lifting.

- Use a team approach in removing centrifuge rotors. No matter how big or strong someone is, it is best to lift with two people.
- Design a harness to wrap around the rotor and attach straps on each side of the rotor. Two people can pull the rotor out from the centrifuge with the harness, reducing low back flexion and decreasing the load by half. Or implement a pulley system attached to the ceiling above the centrifuge.
- Use a cart to transport rotors.
- Look for manufacturers who produce lighter-weight rotors.⁹

*Heavy equipment and supplies.*¹

- Learn proper lifting techniques. Refer to our web page on lifting and back care: <http://working-well.org/Website/backrules.html>
- Place heavy equipment on an elevated stand or use lifting tools when needed.

*Overhead lifting.*¹

- Store heavy objects on shelves below shoulder height when possible.
- Use a stable footstool or stepladder to reach objects stored on shelves.
- Avoid asymmetric lifting (twisting while lifting). The object should be directly in front of you when you lift.
- Store frequently used materials on shelves no higher than shoulder height.
- Store frequently used materials close to you to avoid reaching. Use rotating carousels when appropriate.

RESOURCES:

Cell Counters:

ThermoFisher Automated Cell Counters. <https://www.thermofisher.com/us/en/home/life-science/cell-analysis/cell-analysis-instruments/automated-cell-counters.html>

Daigger Lab Equipment & Supplies, 620 Lakeview Parkway, Vernon Hill, IL 60061. 800-621-7193. <http://www.daigger.com/electronic-differential-tally-counter-16486-group?q=cell%252bcounter>

Foam tubing:

GripWorks, Sinclair & Rush, Inc, 123 Manufacturers Dr., Arnold, Missouri 63010. 800-347-4783. <http://www.gripworks.com/foam-grips.htm>

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