Laboratory Ergonomics Guideline

1. Purpose

The purpose of this guideline is to provide guidance on preventive measures for specific laboratory operations that have been identified as high risk to develop musculoskeletal disorders (MSDs). MSDs are injuries or disorders of the muscles, nerves, tendons, joints, cartilage, and spinal discs.

2. Scope

This guideline is considered best practices for KAUST's laboratory ergonomics program. It is expected that KAUST research laboratories to apply this guideline to eliminate and/or reduce high risk tasks and to ensure the safety and well-being of laboratory staff when operating under the Laboratory Safety Manual.

The following tasks commonly performed in the laboratories have been identified as high ergonomic risk:

- Laboratory Workbenches
- Laboratory Chairs
- Chemical Fume Hoods
- Biosafety Cabinets
- Glove Boxes
- Computer Workstations in the Laboratories
- Pipetting
- Microscopy
- Cell Counters
- Micromanipulation
- Centrifuge Rotors
- Overhead Lifting
- Lab Carts
- Dispensing Pumps
- Large Volume Liquid Handling
- Vortexing
- Office/ Desk Workstations

Each of these equipment/ tasks is reviewed in depth, with hazards and proven control measures described. Apply this guidance by selecting and specifying and in some cases replacing equipment, modify your procedures and work habits, procure ergonomically designed tools and other ergonomic assists.

3. Introduction

Ergonomics is the science of adapting the job, the equipment and the human to each other for optimal safety and productivity. Its concepts are used to design working environments,

procedures and tools that alleviate physical and psychological stress, reduce the potential for injury and improve efficiency. When sound ergonomics concepts are not applied, musculoskeletal disorders are a likely result.

When working in a laboratory, there are many activities unique to that environment that can increase the risk for musculoskeletal disorders, particularly repetitive strain injuries, which affect the muscles, tendons, ligaments and nerves. The types of repetitive strain injuries commonly found among laboratory personnel are:

- Hand: Tendonitis and Tenosynovitis especially DeQuervain's Disease and Trigger Finger), Carpal Tunnel Syndrome
- Shoulder: Rotator Cuff Tendonitis
- Neck: Thoracic Outlet Syndrome
- Wrist: Ganglion Cysts
- Back strain

There have been many ergonomic improvements made in the laboratories in recent years which have reduced the frequency and severity of these injuries, but there is still much work that can be done to further reduce the potential. This document provides laboratory personnel with the tools for evaluating your work environment for ergonomic hazards and gives you guidelines for how to effectively address the hazards.

If you need help in assessing your job and equipment, contact the Research Safety (HSE@kaust.edu.sa) for an ergonomic evaluation.

Causes of Musculoskeletal Disorders

The broad range of musculoskeletal disorders, including repetitive strain injuries and cumulative trauma disorders are a group of health problems caused by overuse or misuse of muscles, tendon and nerves. They are disorders of the muscles, joints, nerves, tendons, ligaments, cartilage, or spinal discs, mainly occurring in the neck, back, arms and wrists. Musculoskeletal disorders are caused by any combination of the following:

Risk Factors

- Awkward Posture – Positions of the body parts away from their neutral position. These postures can put stress on the joint and its associated muscles. Negative posture factors are flexion/extension of the wrist, abduction of the shoulders ("winged elbows"), flexion of the shoulders (reaching overhead), bending or twisting at the waist, bending the neck, bending of the back, twisting, outstretching arms or legs, gripping, crouching shoulders and slouching.
- Contact Stress is a sustained contact between a body part and an external rigid object, such as resting the wrist or forearm against a hard surface, hard edge or corner.
- Duration is the period of time that a body part is exposed to an ergonomic risk factor. Longer durations of exposure with inadequate rest breaks increase the severity of other risk factors.

- Force Exertion is the physical effort applied by a body part to perform a task. Higher forces combined with longer durations can increase the severity of the risk. Examples include: Pushing/pulling, lifting, gripping, and pinching.
- Forceful Impact is a motion where a body part incurs a shock impact to an object. Examples include: using a hand to strike an object.
    - Repetition is the repeated performance of motion that includes other ergonomic risk factors such as force and/or awkward posture. Severity of the risk increases with higher repetition of motions combined with the other ergonomic risk factors.
    - Static Postures occur when a body part is held in a single position over a long period of time. The severity of a static posture risk can increase if the posture is also awkward and/or if continual force is applied. Examples include: sitting or standing in single position for a long duration.
    - Time Constraints – When people must work quickly to complete a task in a given amount of time, the hazards of other risk factors can increase.
    - Pinch Grip – Occurs when a tool is grasped between the index finger and the thumb for precise manipulations.

Humantech, 2014

Symptoms of Musculoskeletal Disorders

Early detection of symptoms helps prevent the onset of musculoskeletal disorders. Symptoms include low back pain, pain in the thumb, finger, wrist, forearm, elbow, neck and shoulder, numbness, weakness, clumsiness, loss of strength, decrease in joint motion, aching, swelling, pain, redness, tingling and burning, cracking or popping of the joints.

Development Stages

While the onset of musculoskeletal disorder symptoms can be either gradual or sudden, severe injuries generally do not appear suddenly. The symptoms usually develop progressively. Three stages of the disorder are identified:

Stage 1 - Minor aches and pain are experienced while performing a task. The pain subsides given a break and overnight. This stage of the condition may persist for months but is reversible if the risk factors are quickly identified and ergonomic modifications are made.

Stage 2 - Symptoms begin early and last well past cessation of the activity and may disturb sleep. The capacity to perform the repetitive activity is reduced. This stage of the condition can persist over months and medical intervention is often needed.

Stage 3 - Symptoms are experienced almost constantly, with even non-repetitive movements being painful. Long- term damage is possible and medical attention is necessary.

Source: Humantech 2014

It is obvious that preventing Stages 2 and 3 should be the highest priority. Therefore, early detection and vigilance of Stage 1 symptoms, correlating it to the work environment, if such a correlation exists, and taking steps to reduce the ergonomic hazards, should be of the utmost importance. Report early discomfort to your manager and HSE Research Safety. And remember, it is your responsibility to report "onset of any pain or symptoms that could be related to your work." Examples include neck, back, hand, or arm pain from ergonomic issues; strain from lifting/carrying heavy objects; repetitive motion disorders.

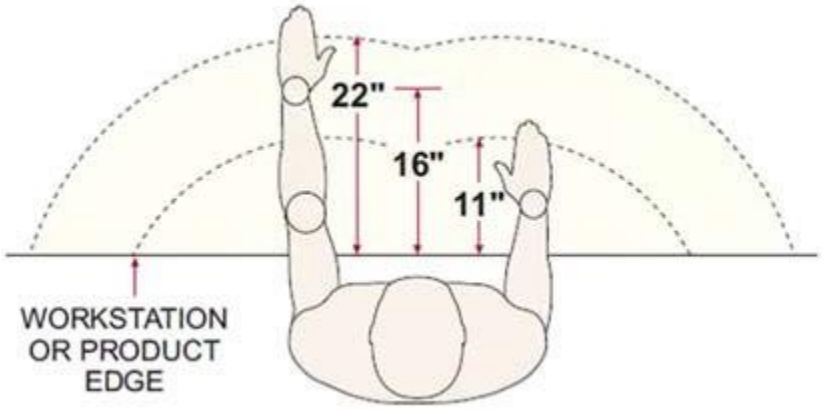
If you believe you have any symptoms of a job-related musculoskeletal disorder, enter an incident report in the HSE incident reporting system. HSE will be notified for an ergonomic evaluation of your work area will be conducted.

General Principles

The first step in evaluating your work environment in the laboratory is to understand the risk factors which create ergonomic hazards. You are then ready to control them by modifying the work environment, equipment and work practices. The following are general principles for reducing ergonomic risk factors which should be followed when performing laboratory activities. Equipment and Task Specific Solutions will also be covered in this document.

1. Alternate between sitting and standing positions.
2. Take frequent micro-breaks every 15 to 20 minutes.
3. Alternate between work tasks that use different motions and/or body parts.
4. Use automated technology wherever available and practical.
5. Obtain tools, where available, to facilitate manual tasks.
6. When possible, plan work tasks to include a variety of movements to avoid static postures and repetitive motions.
7. Alternate between using the right and left hands (make sure equipment is ambidextrous).
8. Use alternate grips when performing fine motor tasks (e.g. switching between holding forceps with first and second digits and with thumb and first digit).
9. Avoid contacting or resting wrists or forearms on hard surfaces, sharp edges:
    a. Apply padding, use padded rests or elbow padded sleeves.
    b. Select containment trays which do not necessitate placing arms or wrists on the edge.

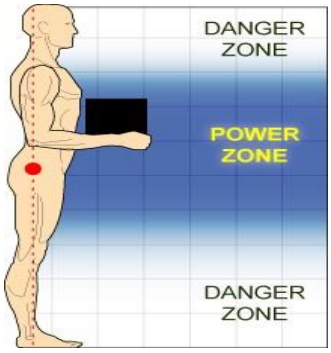
10. Arrange your workstation so that the most often used items are directly in front you and always try to avoid full arm extension.



Source: Humantech 2014

11. Use aids, such as turntables to avoid reaching and mechanical shakers to avoid manual shaking.
12. Adjust the workstation so that you can maintain proper posture:
    a. Shoulders and neck in a neutral position (i.e. shoulders not raised and neck not bent)
    b. Head upright
    c. Arms and elbows close to sides
    d. Wrists in neutral position (i.e. neither flexed nor extended)
    e. Back straight and upright
13. In order to maintain proper posture when performing tasks, obtain equipment that will enable you to do so. For example:
    a. Use a cart with a scissor mechanism which can vary heights of containers
    b. Use low profile waste containers to avoid elevating arms/shoulders to repetitively dispose materials into.
    c. Use step ladders or portable platforms to prevent overhead reaching while leaning into freezers.
    d. Use an ergonomic laboratory chair and adjust appropriately.
14. When seated, the thighs should be parallel to the floor and feet firmly planted on the floor or on a footrest.
15. For seated or standing jobs, the work surface and/or chair should be adjusted such that work can be performed at the following recommended heights:
    a. Precision work: above elbow height
    b. Light work: just below elbow height
    c. Heavy work: 4 to 5 inches below elbow height

16. When pouring multiple times, safely balance the container on hard surface ledge and tip it to pour.
17. Avoid repetitive tasks with hands and arms extended and unsupported. Obtain a soft padded surface to support the forearms (portable padded arm rests are available for biosafety cabinets).
18. Review the weight of the equipment which you need to lift and evaluate where lighter alternatives are available.
19. Reduce volumes and weights of containers and their contents, where possible.
20. When ordering new equipment, look for the companies and models that incorporate ergonomic features and replace older equipment with “ergonomically friendly” equipment where practical. Be cautious to evaluate the ergonomic benefits they claim. HSE Research Safety can help.
21. When lifting heavy objects, keep items in your “power zone” (i.e. between mid-thigh and mid-chest height – think of a “strike zone” in baseball). This is the zone where arms and back can lift the most with the least amount of effort.



22. Contact HSE Research Safety for evaluation: HSE@kaust.edu.sa
23. If you are involved in pipetting, thoroughly address the multitude of ergonomic issues in the next section to reduce the risk factors of one of the leading causes of musculoskeletal disorders.
24. Use anti-fatigue matting when it is necessary to stand for long periods.
25. Improve illumination where necessary to prevent eye strain. Use task lighting.
26. When seated, use an adjustable lab chair. It should have adequate foot, leg and back support.

27. When standing at a workstation, design it to be a workstation and not just install a monitor and keyboard on a lab bench. You may use it infrequently at the present time but be ready to adjust to workload increases. Ensure to build in sit-to-stand capability as appropriate as seen in picture below.

28. Avoid reaching. Ensure the work and equipment is at the desired height. Get help if needed.
29. Perform stretching exercises.

As you go about evaluating your work environment, understand that older equipment and methods rarely addressed ergonomic hazards. Innovative approaches and modern “ergonomically friendly” equipment can prevent the pain and suffering that can result from an at-risk ergonomic condition or practice.

4. Task Specific Solutions

Tasks commonly performed in the laboratories have been identified as high ergonomic risk:

- Laboratory Workbenches
- Laboratory Chairs
- Chemical Fume Hoods
- Biosafety Cabinets
- Glove Boxes
- Computer Workstations in the Laboratories
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- Microscopy
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4.1. Laboratory Workbenches

Laboratory workbenches are at fixed heights and have been designed using international standards (ISO) and general guidelines suggested by the U.S. National Institute of Occupational Safety and Health (NIOSH). These guidelines are as follows:

- Precision Work - Workbench height should be above elbow height.
- Light Work - Workbench height should be just below elbow height.
- Heavy Work - Workbench should be 4-6 inches (10-15cm) below elbow height.

Preventive Measures:

1. If seated, use a fully adjustable ergonomic chair or stool with built-in solid footrest or an adjustable footrest.
2. Remove drawers, supplies and other materials underneath workbenches to provide leg room.
3. Use an ergonomically designed footrest if your feet do not rest comfortably on the floor.
4. Use padded arm rests for repetitive jobs.
5. Use anti-fatigue mats if you will be standing for long periods of time while working at the laboratory workbench.

4.1.1 Risk Reduction Plan - Leg Hole

Objective: Provide appropriate leg space while performing seated tasks to reduce awkward postures.

Action Required:

- Review bench top knee holes and biosafety cabinets (BSCs to ensure leg space is appropriate for seated tasks
- Relocate items stored in knee holes to provide leg space while seated
- Review seated tasks and locate at bench top locations with knee holes
- DNA Gels should be located where staff can sit while loading gels
- Provide anti-fatigue mats for standing, when necessary
- Provide footrests (i.e. bench tops and BSCs) when seating does not allow proper foot support

4.2. Laboratory Chairs

Risk Factors:

- When the chin is dropped or raised, muscles have to work harder to support the head. Compensating for a too high or too low head position puts strain on neck and back muscles.
- Not making contact with the chair back, the trunk works harder to balance the body. The pelvis is rotated backward and the lower curve of the spine is rounded out, causing a slump.
- If the feet are not in contact with a firm surface, the legs become a load on the spine or the worker will stretch his or her ankles and legs to make contact with the floor.

- If the seat of the chair is tilted too far forward, the legs do more work to push the body back into the chair.
- If the seat is tilted too far back, the knees are positioned over the thighs, rotating the pelvis back and rounding out the spine. This reduces structural capacity of the spine.

Proper Ergonomic Chair:

1. Have at least 5 legs for stability if on casters (wheels).
2. Casters (appropriate for floor material) must allow for easy movement when seated.
3. Seat height should be pneumatically adjustable while seated.
4. Seat width of 17 to 20 inches (43-50 cm) suffices for most people and should be deep enough to permit the back to contact the lumbar backrest without impinging nerves in the backs of knees.
5. The seat slant should be adjustable (0 to 10 degrees).
6. The seat should swivel easily.
7. Adjustable arm rests.

Adjust the chair properly and sit such that:

1. Your chin is level.
2. Your back rests firmly on the backrest.
3. Your feet contact the floor or a footrest.
4. Do not tilt too far backward or forward.
5. Arms are supported by the arm rest at same height as worktable.

4.2.1 Risk Reduction Plan – Lab Chair Setup

Objective: Provide appropriate seating for the lab task being performed

Action Recommended:

- Provide proper back support to staff performing tasks requiring longer durations of sitting
- BodyBilt Lab Stool (https://bodybilt.com/ergonomic-seating/by-type/stools-2/)
- BodyBilt Sola (with cushioned teardrop backrest)
- Ensure chairs provided for shorter seated durations are in good condition and provide adequate support

4.3. Chemical Fume Hoods

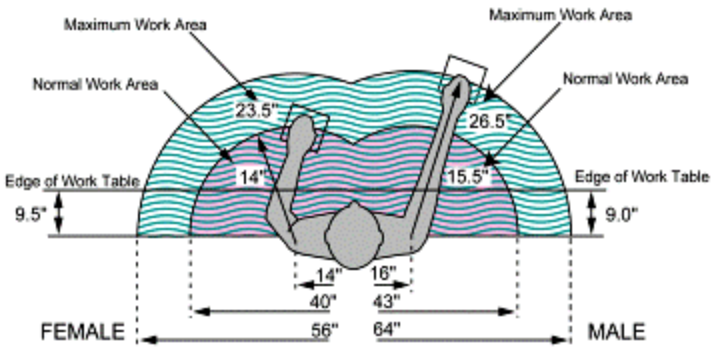
Risk Factors: Fume hoods are not the most ergonomically friendly pieces of equipment. When using a fume hood, especially an older one, you may experience:

- Constrained knee and leg space.
- Contact pressure on the forearms, wrists, knees, and legs.
- An awkward posture of the neck and back.
- Constrained and unnatural body positions.
- Working with your elbows in a winged-out position.

- Overreaching.
- Repetitive motions of the hands, wrist, and forearms, especially when pipetting is involved.
- Prolonged standing in unnatural positions or in restricted postures.

Preventive measures:

- Adjust your chair height and sit back in the seat using the backrest.
- Work at elbow height and try not to raise your arms above shoulder height.
- Avoid overreaching by placing materials close to you.
- Avoid resting arms on sharp edges of the fume hood.
- Take breaks to relieve pressure caused by leaning on the front edge of the fume hood.
- Place disposal bins close by and at elbow height.
- If possible, remove drawers and supplies from under the fume hood for extra leg room. When there is limited legroom, standing or partially seated postures will reduce forward bending or reaching, leading to less strain on your back and shoulders.
- Make sure the viewing window is clean to reduce eye strain.
- Support your feet on a foot ring or platform.
- If you must stand at the fume hood, wear proper footwear with good cushioning or use anti-fatigue floor mats.
- Remove false fronts and supplies from under the work area.
- Use footrests and foot rings for leg support.
- Avoid resting your forearms on hard edges.
- Pad forearms, elbows or hard edges (Avoid interference with air flow).
- Position work supplies as close as possible.
- Place equipment on approved turntables for easy retrieval.
- Take short breaks to stretch muscles and relieve forearm and wrist pressure.



4.4. Biosafety Cabinets

Biosafety cabinets present ergonomic hazards which are mostly due to lack of adjustability and leg room. The following are recommended for control of ergonomic hazards associated with the use of biosafety cabinets:

1. Purchase an ergonomically adjustable Biosafety Cabinet (height can be adjusted).
2. Use an ergonomically designed chair that provides adequate back support, adjustable seat angle, adjustable arm rests and height adjustability between 28 inches to 33 inches.

3. Use adjustable footrests for individuals whose feet do not rest comfortably on the floor.

4. Apply closed-cell foam padding to the front edge of the biosafety cabinet (away from the downdraft) or workbench. Alternatively, factory-applied movable padded armrests may be installed external to the cabinet to provide support for the arms and still maintain the required airflow. This reduces contact forces by increasing the surface area that comes in contact with the forearm and therefore reduces the chances of impinging nerves, tendons, or blood vessels. If applying closed cell padding to the front edge of the Biosafety cabinet, ensure the material can be properly decontaminated.

AliEdge gel supports (www.alimed)

AliMed Ulnar Gel Pads

Arm Rest (Fisher Scientific)

5. Remove drawers, supplies, refrigerators, etc. from under the biosafety cabinets in order to provide leg room.
6. Use a turntable to store equipment near you. This reduces excessive reaching and twisting, which places an increased load on the lower back.
7. Position materials in the cabinet and on the bench top as close as possible to you to avoid extended reaching without compromising containment of the cabinet.
8. Use anti-fatigue matting for where you must stand for extended periods of time.
9. Take frequent mini breaks to perform stretching exercises.

Newer biosafety cabinets are now designed with strong ergonomic considerations. Desirable features for the new biosafety cabinets include:

1. A perforated front grill reduced by 1 to 2 inches to bring the work platform closer to the laboratory worker.

2. Adjustable height (hand-crank or hydraulic lift) - may not be possible for all biological safety cabinets or in all laboratories.
3. Non-glare glass on the sash window and/or adjustable Plexiglas barriers.
4. A platform configuration with "wells" for placement of tall containers.

4.5. Glove Boxes

General tips while using glove boxes:

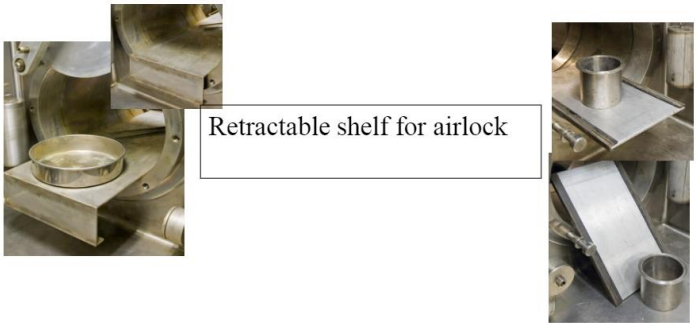
- Respect your body and make frequent postural or task changes.
- Place items within a comfortable reach or use reach assist tools.
- Consider using a lazy Susan turntable (rotating tray) so nothing is farther than fingertip length away from you.
- Avoid pinch grip/ use a more open hand power grip, or design tooling to reduce pinching.
- Using anti-fatigue mats will help with prolonged standing.
- Eliminate sources of glare.
- Avoid continuous tight grasp of objects - do not reach over the top and grab/move items which will put a lot of stress on elbow.
- Use a footstool or platform to improve alignment with the spine; shoulder angle should be below 70˚ (degree).

Recommended Platform Height	Height	Shoulder Height
2 in (5 cm)	68-67 in (173-170 cm)	57-55 in (145-140 cm)
4 in (10 cm)	66-63 in (168-160 cm)	54-52 in (137-132 cm)
6 in (15 cm)	62-58 in (158-147 cm)	51-47 in (130-119 cm)

Use platform to avoid overstretching

Work platform

Shoulder stress when using airlock



Design a retractable shelf airlock for easy reach

- When the visual field is impaired, so is productivity and dexterity.

- Full view windows are ideal

4.6. Computer Workstations

Risk Reduction Plan

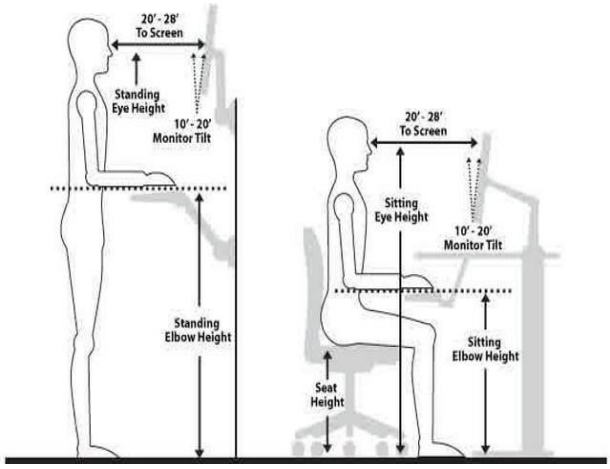
- ***Objective: Provide ergonomic set up and support for computer workstations***

- ***Action Required***:
  - Determine appropriate posture (seated or standing) for tasks performed at a computer workstation
  - Adjust computer workstations, as needed to support determined appropriate postures
    - Seated locations should have appropriate leg space and foot support
    - Hand/wrists should be at the same height or slightly below their elbows when placed on the keyboard
    - Monitor should be adjusted so the eye height is within the top 1/3 of the digital display
  - For laptops, use a laptop stand and external keyboard to position the digital display at the appropriate height
  - For areas in which ergonomics are difficult, consider using mobile carts or platforms (i.e. ErgoTron).

Many researchers spend 50 percent or more of their day entering data or performing other computer tasks with their keyboard and mouse resting on a lab bench. Lab benches are not designed ergonomically for computer use. Most of these lab benches are too high and require the researcher to elevate the arms which excessively deviates the wrists while

inputting data. Depending upon the location of the mouse, awkward reaches and manipulations of the mouse with bent wrists may occur.

The following illustration depicts neutral posture at standing or seated height.



Here are recommendations for control of ergonomic hazards associated with the use of computers in the lab:

1. Do not place keyboards/mouse on lab bench. Install adjustable keyboard platforms under lab benches which accommodate use of the mouse beside the keyboard.
2. Position computer workstations in corners or other areas away from doors, entrances, and passageways.
3. Provide fully adjustable ergonomic seating (impervious plastic, non-fabric).
4. Place monitors so the user's viewing distance are between 18 and 30" (45-75 cm).
5. Place monitor so the top of the screen is approximately eye level. This allows the eyes to naturally gravitate toward the center of the screen.
6. Use a document holder placed adjacent to and in the same plane as the computer screen.
7. Provide footrests, where possible, for individuals in order for them to change leg positions throughout the day.
8. Provide for a choice of keyboards and mouse or other input devices for individuals who have existing musculoskeletal problems.
9. Encourage mini breaks of 3 to 5 minutes for every 30 minutes of keyboarding or mouse work. These breaks can be spent doing mild hand exercises or stretches.
10. Laboratory personnel should not go from keyboarding to pipetting activities (or vice versa) without an adequate break (at least 15 minutes) to allow the hands to recover.
11. Use sit-to-stand equipment. For example, the ErgoTron Styleview and Neo-Flex mobile workstations.

4.7. Pipetting

Risk Reduction Plan – Pipetting

- ***Objective: Reduce hand activity and repetitive motion***

- ***Action Required***:
  - **Automate tasks to reduce repetitious hand activity level**
    - ✓ First approach: utilize robotics
    - ✓ Second approach: electronic pipettes
  - **Use a dispensing pump for multiple transfers of liquids**
  - **Incorporate electronic pipettes.**
    - ✓ Recommended serologic pipette:
      - *Drummond Portable Pipet-Aid XL*
      - *Ovation BioNatural Pipette*
  - **Require Microbreaks: Take 30 sec to 1 min microbreaks per 30 min of pipetting to stretch, rotating hands and relax shoulders and forearms**

Pipetting is the leading cause of repetitive strain injuries in the biological laboratory. If you are performing pipetting on a regular basis, it is imperative that the concepts in this section be applied to prevent the injuries described.

Pipetting Injuries

The following table details the unsafe actions of pipetting, the early symptoms of that action and ultimately injury:

PIPETTE RELATED INJURIES		
POSSIBLE CAUSE/PIPETTING ACTION	**SYMPTOMS**	**INJURY**
Tip insertion and using wrist movements to manipulate the pipette.	Pain and inflammation in the wrist and elbow.  Source: Cardinus 2014	Tendinitis (Inflammation of the tendon)
Gripping the pipette tightly. Performing repetitive and forceful plunger/tip ejection activities with the thumb.	<u>DeQuervain's</u> • Pain on the thumb side of the wrist • Thumb may be tender to touch, and a small knot may be felt • The thumb may lock in position when bent <u>Trigger Finger/Pipettor's Thumb</u> • Pain where the finger or thumb joins the palm • Swelling • Finger or thumb lock in position while being extended	Tenosynovitis (paratendonitis) (inflammation of the sheath that surrounds the tendon) Specific forms: • DeQuervain's • Trigger Finger • Pipettor's Thumb
Flexing, extending, and rotating the wrist while pipetting, and inserting and ejecting.	• Weakness in the hand. • Numbness or tingling in the thumb, index and middle fingers. • Numbness or tingling of the palm of the hand. • Fingertips, wrist pain. • Reduced finger and thumb movement. • Sharp, radiating, pain from hand to elbow or neck.	Carpal Tunnel Syndrome (compression of the median nerve and vessels running through the carpal tunnel in the wrist)

PIPETTE RELATED INJURIES		
POSSIBLE CAUSE/PIPETTING ACTION	**SYMPTOMS**	**INJURY**
Tip insertion and extension of the pipette away from the body.	• Elbow pain that gradually worsen. • Pain radiates to the forearm and back of the hand when grasping or twisting. • Weakened grip. • Pain when the tendon is gently pressed near where it attaches to the upper arm.	Tennis elbow (epicondylitis) (inflammation of the muscles of the forearm, or their tendons near their origin on the bone of the upper arm)
Resting the elbow on a hard lab bench while pipetting.	• Numbness or tingling in ring and little finger. • Loss of finger and hand strength, inability to straighten fingers. • Sharp sudden pain when elbow is touched.	Cubital Tunnel Syndrome (compression of the ulnar nerve in the cubital tunnel in the elbow)

Specific risk factors associated with pipetting include:

Pipetting Risk Factors
The risk factors leading to musculoskeletal disorders involving pipetting are as follows:

Repetition - motion of the hands, forearm and thumb, or fingers. Research work can necessitate hundreds of manipulations per day.

Force Exertion - force of the thumb – manual pipettes use thumb pressure. Pinch grips when handling pipette tips and opening vials.

Note: Higher viscosity liquids require more force and can become an additional risk factor.

Awkward Posture – poor posture, if not addressed, can easily be inherent in pipetting. Holding awkward postures (i.e. “static” posture), including:

- Standing for long periods of time.
- Wrist bending and twisting.
- Extending elbows out to the sides.
- Neck bending.
- Reaching too far away from the body.

Contact Stress – numerous hard surfaces in the lab environment can encumber the researcher in a poorly set up ergonomic pipetting operation.

Time Constraints – often tasks must be performed within a specified interval.

How to Limit these Risk Factors

Applying sound ergonomic principles is essential in preventing musculoskeletal disorders while pipetting. These principles are applied by addressing the equipment and the procedures.

Optimal Selection, Customization and Design

When selecting a pipette for use, there are several factors which should be taken into consideration. Choose the best type of pipette for the application, while considering ergonomics, nature of tasks, cost and practicality.

There are many pipettes now available on the market which incorporates the principles of ergonomics to reduce the potential for repetitive strain injuries. The following features are available:

1. Electronic – reduces forces.
2. Multi-Channel – combines many steps, but requires higher forces.
3. Latch Mode with Magnetic Assist– reduced forces, thumb does not need to be held down.
4. Automated (robotics technology) such as PlateMate Plus –eliminates ergonomic hazards.

Choose a pipette with as many automated features as possible and a sound ergonomic design. Apply the following criteria:

1. Use automated, robotic pipetting systems (e.g.: PlateMate Plus) where available for project. They eliminate many ergonomic hazards.
2. Choose electronic or latch-mode pipettes whenever possible for repetitive pipetting
    a. Use an electronic operated or a latch-mode pipette to replace manual plunger-operated pipettes. Both units reduce the need for excessive thumb force and repetition.
    b. Use an electronic pipette with mixing functions for tasks such a mixing or aliquotting.
3. Choose multichannel pipette for large aliquotting tasks to reduce repetition.

4. Use shorter pipettes. This decreases hand and arm elevation and consequently awkward postures.
5. Choose pipettes which are as light in weight as possible, while balancing out other risk factors.
6. Use thin-wall pipette tips that fit correctly and are easier to eject.

Manually Operated Pipettes

1. Be comfortable to hold and have a good feel, with a good grip and be contoured to fit into the hand.
2. Be customized to the user's hand size. Different sizes are available.
3. Have a well-designed and adjustable finger rest to increase user comfort.
4. Require the use of the trigger finger to aspirate, and the thumb to dispense.
5. Require as little force as possible for all aspects of operation.
6. Require minimal force to control (newer pipettes have thumb activated plungers and trigger finger aspirator mechanisms requiring less force to activate).
7. Have easy tip ejection and fitting (geared tip ejection mechanisms available which significantly decreases ejection force).
8. Have a convenient plunger position to avoid over-stretching the thumb.
9. Be suitable for left or right-handed users (ambidextrous).
10. Incorporate an easy to set and read dosage.
11. Have a design that allows a neutral positioning of the hand and wrist (not bent).
12. Have finger rests which are made horizontally adjustable for increased comfort and adaptability for left- and right-handedness, as well as user preference.
13. Location of controls:
    a. Multi-finger controls help distribute the force among several fingers rather than continuously using the same finger.
    b. Some pipettes have a button on the top which may require the thumb to be repeatedly extended out of a relaxed, neutral position - this is undesirable.

Work Practice Controls

1. Use adjustable chairs with built-in solid footrest or separate adjustable footrests. Elevate the chair rather than reaching up to pipette.
2. Adjust the workstation to ensure that work involving the use of the arms are not in an elevated position for lengthy periods. Provide padded elbow and forearm rests.
3. Prevent twisting and bending of the wrist, neck and arms, elevation of the shoulders, and overreaching, by adjusting the height and position; heights should all be approximately the same, and these items should be within easy reach in a logical work order:
    a. Sample holders (e.g. place on a tilt),
    b. Solution container(s),
    c. Waste receptacle(s) for used tips – keep at low height (e.g. no higher than top of tubes or plates being filled), and

d. Cell plates; do not stack excessively high - maintain heights at a low profile.

4. Work with arms close to the body to reduce strain on shoulders; keep samples and instruments within easy reach; use turntables.
5. Keep head and shoulders in a neutral position (bent forward no more than 30 degrees).
6. Do not twist or rotate wrist while pipetting. Keep wrist as close to neutral position as possible.
7. If it is necessary to stand for long periods of time during pipetting, provide anti-fatigue matting. Rotate between standing and sitting if pipetting for long periods.
8. Alternate left and right hands to pipette.
9. Hold pipette with relaxed grip.
10. Use minimal pressure while pipetting. Do not apply any more pressure than necessary.
11. Use minimal force when applying pipette tips. Stand if necessary.
12. Use light amount of force or two hands to change tips.
13. Clean pipette on a regularly scheduled basis. This reduces "sticking" and improves quality of work.
14. Post protocols straight ahead at eye level to prevent bending or twisting.
15. Do not work with any part of forearm or hand resting on a hard surface.
    a. Use padded elbow rests (made specifically for work in Biosafety cabinet).
    b. Apply soft padding for front ridge of Biosafety cabinets and/or apply padding to edge of the work surface to avoid resting your elbows on hard/sharp edges.
    c. Select trays and other equipment appropriately to avoid resting on hard surface.
    d. Wear elbow padded sleeves to reduce pressure on arms while working at bench.
16. Limit periods of continuous pipetting to 20 minutes or less; take frequent short breaks (e.g. 2 minutes for every 20 minutes of pipetting), and stretch.
17. Rotate pipetting tasks among other people in order to limit pipetting time.
18. Use gloves that fit properly to avoid undue stress.
19. Perform stretching exercises for upper extremity.

4.8. Microscopy

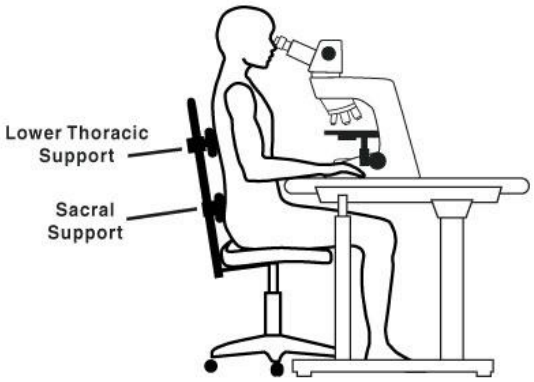
Researchers may use a microscope for prolonged periods. Using the microscope for long hours causes strain on the back, neck, shoulder, eyes, arms and wrists. Working at a microscope that is not at the correct height and angle requires a hunched position and may include contact stress on the forearms from the work surface edge.

Risk Factors

- Awkward and static posture of the lower back.
- Lack of adequate leg and knee clearance under worktable.
- Working with elbows winged.
- Pinch grip when adjusting binocular eyepiece or handling samples.

- Wrist and palm contact pressure in the carpal tunnel area.
- High repetition.
- Eye strain and fatigue.
- Awkward and static posture of the neck and head.
- Raised or shrugged shoulders.
- Awkward hand and wrist postures.
- Sitting/standing for long periods.

There are steps that should be taken to avoid or decrease the occurrence of discomfort and musculoskeletal disorders. Changes may be made to the work environment, work tools, and personal work techniques and habits:



Preventive Measures

1. Design and maintain a proper microscopy workstation
    - Plan for it. Do not assume that an at-risk workstation is acceptable because it is used “infrequently” or for short periods of time.
2. Do not work with elbows winged. Keep elbows close to sides, 90-degree angle.
3. Make sure to work with wrists in neutral (straight) position. Always assume proper sitting position. Ensure proper lower back and thigh support.

4. Use an ergonomically designed chair that provides adequate back support, adjustable height, and adjustable seat angle with built-in foot and forearm rest.
5. Ensure that feet are flat on floor or supported by a footrest.
6. The three curves of your spine, cervical (neck), thoracic (middle) and lumbar (lower) are relaxed and in good alignment.
7. Avoid raising shoulders and bending your neck while looking through microscope's eyepiece. Keep shoulders in resting position. Keep head naturally balanced. Keep neck flexed <20 degrees. Avoid raising shoulders.

Avoid This

Do This

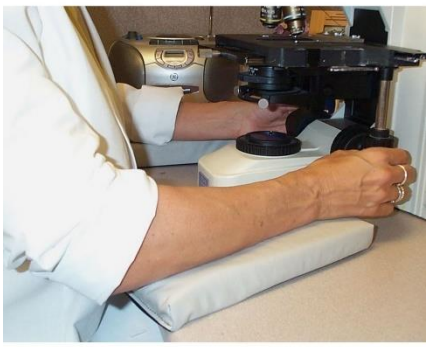
Source: Cardinus 2014

8. Adjust microscope eyepiece's height to allow head and neck proper (upright) neutral posture.
9. Position the microscope as close as possible towards you to ensure upright head position.
10. The microscope operator should be positioned in an upright posture (neutral spine) and reduce tilting your head and rounding of the shoulders and neck to prevent neck strain. This can be achieved by:
    - Adjust the eyepieces and angle of observation, placing it at an angle (angled microscope arm supports) so you can look directly into the eyepiece.
    - Elevating the microscope; use adjustable microscope stands (raise height) or if available use an adjustable work bench.
    - If your microscope is too high and you have to raise your head to use it, then adjust your chair height and use a chair ring or footrest. Place your microscope towards the edge of your work surface so that you can look in an upright position.
11. If available, use a cut-out worktable. This puts you close to the microscope and gives an area for supporting forearms.
12. Prevent repetition where possible. Take adequate small breaks or perform other job tasks that require less repetition, rest your eyes, neck and shoulders. Do not

use a microscope for more than 5 hours per day. Spread the use out over the entire workday, avoiding long uninterrupted periods of microscope work.

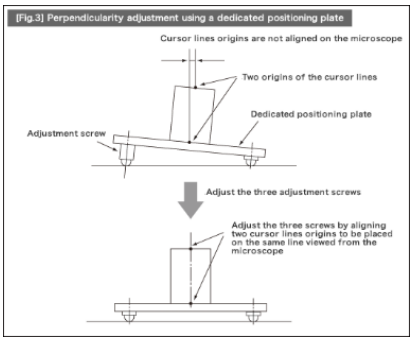
13. Perform stretching exercises.
14. Use television systems or video display terminals where possible to eliminate the use of binocular eyepieces and thus and reduce eye and neck strain.
15. Make sure microscopes remain clean all the time.
16. Provide padded arm rests to support the operator's forearms while using adjustment knobs.
17. Make sure there is **adequate room under the work surface** for the knees and legs so you can pull the chair up to the ocular(s). Approximately 28 inches (71 cm) deep, 28 inches (71 cm) in width is considered adequate.
18. Verify that illuminators are aligned and the light is even and of proper intensity.
19. To prevent contact pressure on the wrists and forearms, apply foam padding wherever possible at the edge of the work surface to avoid resting on hard edges; Wear elbow padded sleeves as appropriate.
20. Follow eyepiece guidelines to encourage the best posture and to minimize the chance for strain or injury:
    - Height adjustable ≥ 4" (10.2 cm);
        - Extensions 3.5" (9 cm).
    - Vertical displacement angle adjustable (0° - 180°);
        - Fit rubber eyecups to eyepieces for comfort.
        - Use an eyepiece-free magnifier, if possible.

Microscope Arm Support



Microscope Arm Rest

Microscope Position Plate



Adjusting the Position Plate

Additional Examples and Solutions

Case-1: C3444 Microscope

Before

Bluesorb® 750 (Berkshire)

After

Microscope arm support (AliMed)
see next page for ordering info

Case-2: C3444 Microscope

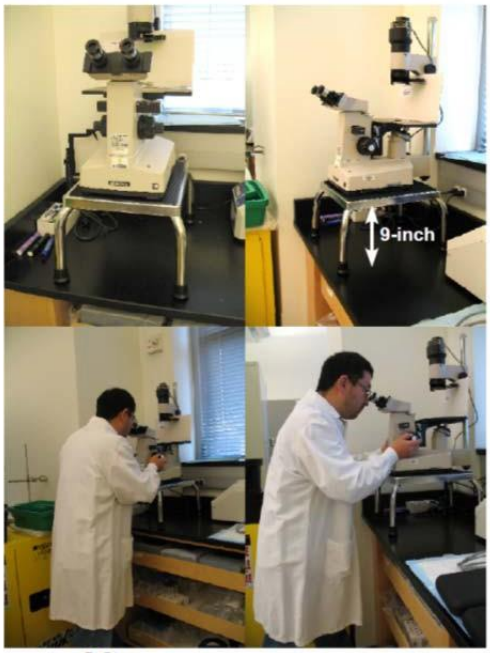
No knee hole

Standing use only

Eye piece too low for standing position

Frequently used for cell culture and membrane preparation experiments

No eye piece angle/height adjustment available



Before

After

Case-5: Elbow support and pad

Before

After

Go to eFinity > Fisher Scientific > enter "14-559-559"

Sartorius™ Biohit™ Elbow Pad

Relieves contact stress, pain and discomfort underneath elbow while pipetting

- Improves pipetting ergonomics
- Forms according to any elbow size or shape
- Coating is pleasant to the skin
- Compact size: requires little desk space
- Durable
- Easy to clean: Can be cleaned using washing up liquid, ethanol (70%) or Biohit Biocontrol decontamination solution
- Non-autoclavable
- Can be used for long pipetting series, work requiring high concentration, e.g. micro plate work, any work where a cushion underneath elbow or wrist is needed

View Specifications

Enlarge

(1 item(s) in product Group)

Items | Specifications

Catalog No.	Description	Price per Unit	Quantity & Availability	Add Item(s)
14-559-559 Sartorius Biohit No.:723103	Visco elastic elbow pad	Each for $81.94	Quantity: Check Availability	Add to Cart; Add to Hotlist

4.9. Cell Counters

1. Choose an electronic differential tally counter to replace manual counter. Soft keys permit accurate and fast counting with decreased hand fatigue.
2. Reduce the force needed to strike the manual counter.
3. Use padded edge protectors to reduce stress on the forearm and wrist.
4. Take frequent short breaks.
5. Rotate tasks among several people.
6. Use an adjustable chair or ergo-task stool with built-in solid footrest.

4.10. Micromanipulation

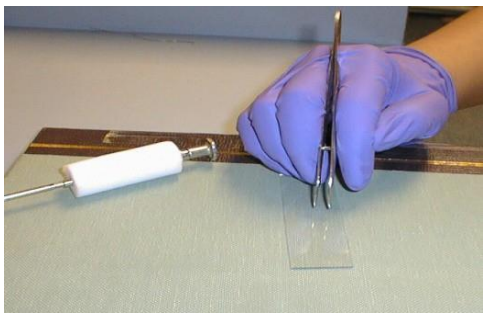
Risk Factors

Many laboratory procedures require repetitive use of the extensor and flexor muscles of the fingers and wrist. For example, removing caps and screw-off lids from vials, reaching into bins, use of forceps, etc. all require the use of these small muscle groups or result in awkward postures. Certain laboratory tasks require using tools that promote pinch grips and awkward wrist postures. A pinch grip requires the tool to be grasped between the index finger and the thumb for precise manipulations. When a pinch grip is used intensively and for a long duration, fatigue may occur in the hand and forearm muscles. Over a period of time, this may contribute to developing a repetitive strain injury.

The following are recommended for control of ergonomic hazards associated with micromanipulation techniques:

1. Use plastic vials with fewer threads to reduce twisting motions during capping and uncapping lids.
2. Use cap removal tools (preferably automated tools) for microcentrifuge tubes or vials:
    - Thermo Scientific Capit-All and Capit-All IS Screw Cap Tube Cappers https://www.matrixtechcorp.com/storage-systems/product.aspx?id=84
    - Microcentrifuge Tube Opener
    - The De-CAP-itator
    - Other options: Kinex Cappers LLC, Kinex Capper Model ES 400

3. Some hand tools are designed to reduce pinch grip force and awkward postures. Older tools may be able to be modified. The basic principle of a modification is to:
    - Build up the part of the tool that the hand holds so it will fit the hand better and reduce pinch force or
    - Change the angle of the handle so your hand holds the tool with a straight wrist.
    - Use non-slip materials to reduce the force needed to hold the tool in position.
4. Practice using forceps between the first and second digits instead of using the thumb and the first digit. Then try alternating between the two positions to reduce the use of the thumb extensors and flexors. The thumb is used repetitively with almost every job task performed in the laboratory.



5. Tilt storage bins toward the worker to reduce wrist flexion while reaching for supplies.
6. Take short breaks and do hand, wrist and forearm exercises.
7. Open caps with specialized opener.
8. Minimize closing caps with thumb.
9. Rotate repetitive movements from one hand to the other, so one hand doesn't do all the work.
10. Open the vial with one hand and close it with the palm of your other hand. This avoids overexerting the thumb.
11. Use pre-printed computer-generated labels to avoid labeling small test tubes and vials by hand.

4.11. Centrifuge Rotor

Risk Reduction Plan – Centrifuge Set Up

- ***Objective: Reduce weight of rotors***

- ***Action Required***:
    - When possible, replace with lighter weight rotors
    - If not possible, determine risk mitigation actions other than lighter rotors

Centrifuge rotors present a unique lifting hazard in the laboratory. They are typically made of 'lightweight' aluminum and titanium metals but are still difficult to lift safely. Centrifuge rotors can weigh up to 32 kg (70 lbs) when fully loaded and are awkward in shape.

The following are recommended for control of ergonomic hazards associated with lifting centrifuge rotors:

1. Advances in the material technology of centrifuge rotors have led to the introduction of carbon fiber composite materials which are up to 60 percent lighter than equivalent metal rotors. Many of the large volume carbon fiber rotors are even designed with a lifting handle allowing users to transport the rotor in and out of the centrifuge with less force and bending, reducing the risk of lower back injury. Convert to these lighter weight rotors when practical.
2. In order to control the ergonomic hazards associated with lifting centrifuge rotors, have a second person assist with the removal of the rotor from the centrifuge.
3. Use a cart or other carrying device to transport rotors.

To avoid frequent reaching, keep wrists straight when taking test tubes in and out of the centrifuge and keep the centrifuge as close to you as possible.

Centrifuge Rotor

4.12. Overhead Lifting

Risk Reduction Plan – Overhead Lifting

- ***Objective: Work within Power Zone (area between the shoulders and knees)***

- ***Action Required***:
  - Adjust shelving height
    - lower top shelf; raise bottom shelf
  - Manage organization of items
    - More frequently used items on middle shelves
    - Heavy items on lower or middle shelves, depending on frequency of use
    - Light items, infrequently-used items on top shelves
  - If deemed not feasible, implement alternative as required by the risk assessment to reduce risk of ergonomic injury

Due to lack of space in the laboratory, equipment and supplies are often stored on overhead shelves. This presents a hazard to the back when placing and removing materials from elevated heights.

1. Avoid storing heavy objects above shoulder height.
2. Use a stable footstool to reach objects stored on shelves.
3. Store materials that are frequently used on shelving unit no higher than shoulder height.
4. Avoid asymmetric lifting (twisting). The object to be lifted should be directly in front of you.
5. Store materials that are frequently used on shelving units no higher than shoulder height.
6. Store materials as close to you as possible or permitted. This reduces excessive reaching for objects.

The following equipment is recommended to assist the lab users in handling overhead materials.

Step Ladder

Step Stool

4.13. Lab Carts

In addition to having complete shelf edges, these carts have the added advantage of ergonomic handles, and they will not corrode on exposure to halides.

Minimize materials on cart when transporting/storing to avoid heavy pushing and pulling that can cause muscle strains.

Rubbermaid carts from Fisher

4.14. Dispensing Pumps

Liquids are heavy and the transfer/movement of liquids can present significant ergonomic risk. Use of liquid transfer systems can reduce ergonomic risk and increase lab productivity.

Risk Reduction Suggestions:

- Automate tasks to reduce repetitive hand activity
    - Use a dispensing pump for transfers of liquids

- Automated solutions available:
    - Multi-drop (small volumes);
    - Hamilton (for larger volumes); and
    - Tecan.

4.15. Large Volume Liquid Handling

Risk Reduction Plan – Liquid Handling

- ***Objective: Reduce lifting***

- ***Action Required***:
    - Require assistance when lifting items over 16 kg (35 lbs) and/or awkward
    - Request buffer prep in smaller batch sizes to reduce weight of
    - container Purchase bulk materials in smaller container sizes
    - Utilize carboys with handles to assist with lifting
    - Use carboys with dispensing spout to eliminate lift/tilt/pour
    - Modify lab configurations to minimize carrying distances
        - ✓ Use risk-based approach to address highest risk configurations
        - ✓ Material handling equipment to aid movement and reduce risk can be used in situations where re-configuration of lab is deemed infeasible

Risk Reduction Recommendations:

- Custom rack to hang 25L/50L bag, with wheels.
- Use pump to move liquid from carboys.
- When moving carboys, watch out for your posture – never lift from lower back. Use your legs, keep load close to body and keep back straight. Get help if needed.
- Thompson 5L flasks with transfer caps are handy.
- Use welders.
- The Meissner 4L bags come with filters.
- Hoist can be useful.
- Harvests in Bottles and Bags up to 20L are place in bins and moved on carts to purifications cold room.
- Harvests larger than 20L and put in bottom drain bags and barrels.
- Use floor scales when possible.

4.16. Vortexing

- Vortexing can present exposure to vibration especially to hands/fingers.
- Recommendations:
    - Use tube holders to minimize prolonged gripping and vibration when vortexing.
    - Bring vortexing equipment into the primary work zone so reaching is minimized. This will protect the tendons in the elbow from vibration.

4.17. Desk/ Office Workstations

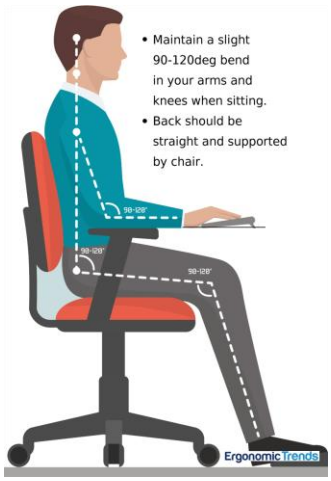
5 Easy Steps to Adjusting Your Computer Workstation

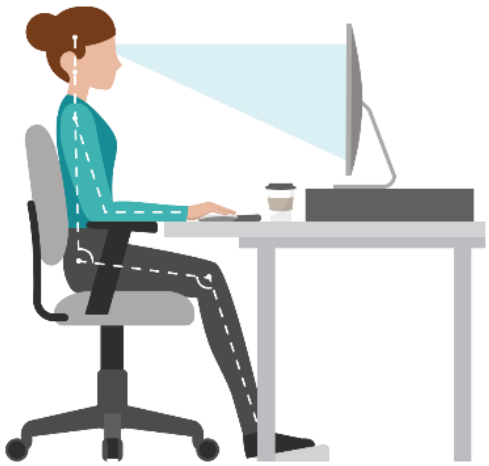
STEP ONE: Your Chair

- Adjust your chair according to the chair video clip below (click on the chair name).

Haworth Zody Ergo Adjustments

Haworth Zody Executive





STEP TWO: Desk/ Computer Workstation

There are many different configurations for computer based workstations available. Computer based workstations should be designed to allow adequate height, depth and work surface to suit the user, the type of work they do and the equipment they use.

The workstation should have the following features:

- a flat smooth surface for the keyboard and mouse so they can be used on the same level;
- space to position all the equipment so that posture or vision is not compromised when completing tasks;

- a suitable height (e.g. 68-72 cm when measured from the top of the workstation to the floor);
- adequate clearance for legs under the desktop; and
- sufficient space under the desk to comfortably stretch legs.

Height adjustable workstations

Height adjustability is another highly desirable workstation feature and all height adjustable workstations need to be to easily adjustable.

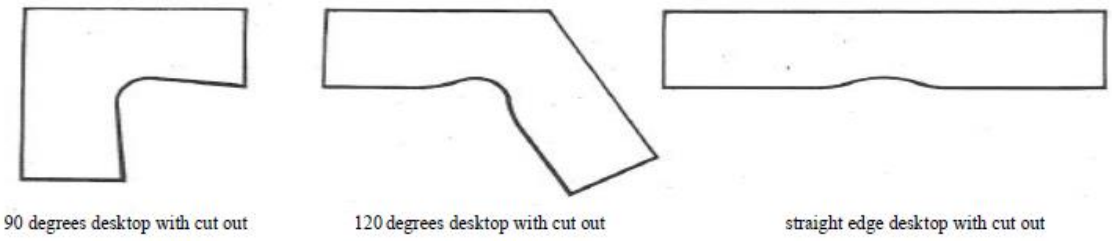
Sit/stand workstations allow the desktop to be used in either the seated or standing position:

- The workstation can be raised or lowered without any disruption to the placement of the equipment or desk items.
- To provide for a standing position, the desktop needs to be able to rise to at least 110 cm.
- It is better practice to have a proportion of workstations in the work area that can be adjusted for both sitting and standing work. This is especially important for highly sedentary work or where work requires sitting or standing positions for long periods.
- Height adjustability for seated positions is particularly important for those who are very tall or short, so they can adjust the workstation to suit their needs.

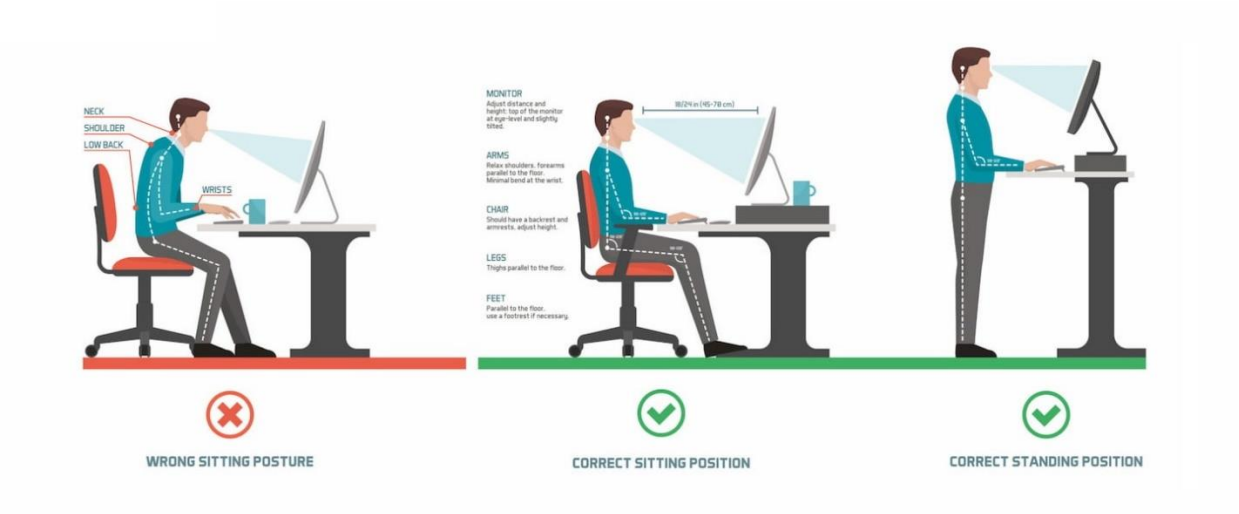
Scalloped desks

There is growing evidence that, compared with a straight edged desk for computer-based work, a scalloped desktop which has a shallow curve cut out at the center (see below), provides:

- more opportunities for forearm support;
- greater desktop space within acceptable reach zones; and
- better work postures when using multiple screens.



Examples of scalloped desktops



When to use a footrest

A footrest should be used if the user's feet cannot be placed flat on the floor. The correct height of the footrest is the distance the feet are off the floor after adjusting the seat height.

A footrest should:

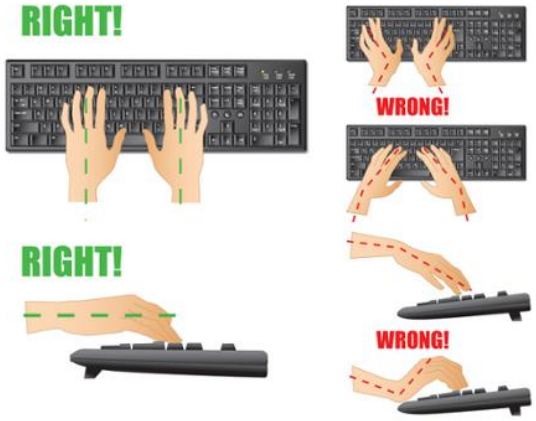
- have a non-slip surface large enough for both feet to rest comfortably (about 30 x 30 cm);
- have an adjustable slope (10-20 degrees) to allow a comfortable ankle position when feet are resting on it; and
- be stable enough so it does not slide or move.

STEP THREE: Setting up your keyboard and mouse

When setting up the keyboard, these general guidelines apply:

- position the keyboard straight in front of the user to avoid twisting the neck or body;
- use a keyboard without a numeric key pad to reduce the width of the keyboard as this allows the mouse to be positioned closer to the body; and
- adjust the angle and height of the keyboard by folding or unfolding the small legs under the keyboard.

To have forearm support, position the keyboard and mouse away from the front edge of the desk. The majority of the forearm is supported on the desk with the fingers sitting comfortably on the middle row of the keys. If sitting at a scalloped desk the keyboard and mouse can be closer to the edge of the desk, as the forearms can be supported by the desk shaping around the body.



Setting up adjustable keyboard platform (where available)

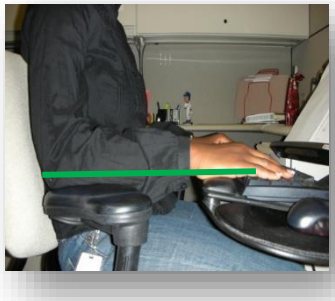
An adjustable keyboard platform (AKP) or tray can provide optimal positioning of keyboard and mouse devices. The keyboard can be raised and lowered; the tray can be angled at a negative tilt (sloping downward away from you) to allow proper hand position.

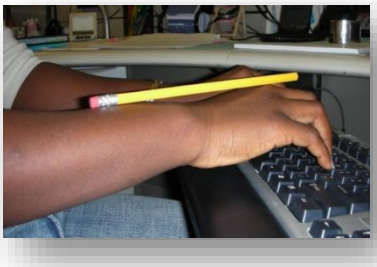
For proper positioning, relax your shoulders and position yourself close enough to the AKP so that your elbows are next to your sides at a slightly open angle (90 to 110 degrees). Your forearms should be parallel to the floor; your hands and wrists should be straight with little to no bend at the wrist.

Wrist rests can help to maintain neutral postures and pad hard surfaces. However, the wrist rest should only be used to rest the palms of the hands between keystrokes. Resting your hands on the wrist rest while typing, is not recommended.

Here's what you need to do:

- Position yourself close to your keyboard tray with the keyboard directly in front of your body.
- Adjust the keyboard height to position your elbows and keyboard at approximately the same height.
- Turn the knob on the keyboard tray mechanism to place a negative tilt (tilting the keyboard away from you) on the keyboard.
- Place your mouse on the mouse pad and adjust the mouse pad location so that you can maintain the proper elbow position while using the mouse.

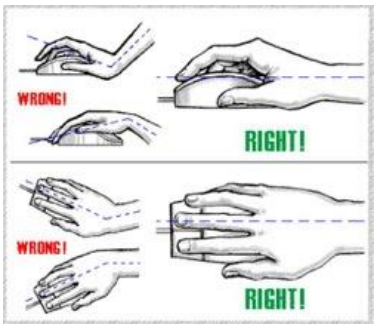


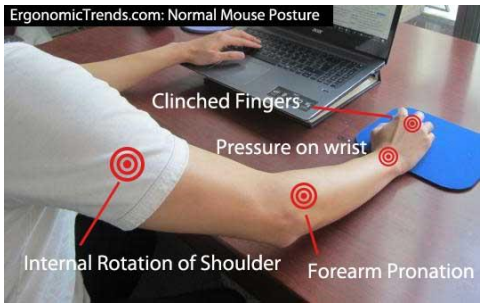


Mouse and other pointing devices

Tips when using a mouse or other pointing devices such as track pads, styluses, tablets, and trackballs:

- keep the device at the same height and as close to the keyboard as possible;
- ensure the mouse fits comfortably in the hand to minimize any undue pressure on the wrist and forearm;
- consider operating the device with the non-dominant hand. Change this operating preference on the computer settings;
- set the tracking speed of the pointer to suit the user, the task and the number of monitors used;
- have enough space and a flat smooth surface so that the wrist can be kept straight
- take hands off the keyboard and mouse when not in use. This assists in reducing muscle fatigue from hovering over the equipment;
- take breaks from the computer to do other jobs that don't involve using pointing devices
- use keyboard short cuts to decrease use of the device; and
- if the device is used for long periods, move the device towards the center of the desk and temporarily reposition the keyboard.





How to place documents

Place the documents as close as possible to the screen with the documents at the same height and viewing distance as the screen.

Move the monitor to one side and place the document in front of you, at the same height and viewing distance as the monitor when inputting data.

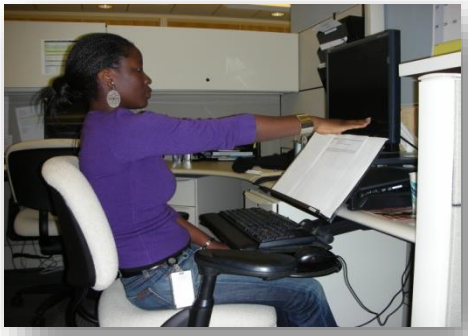
Prop up documents between the monitor and keyboard on an angled reading board.

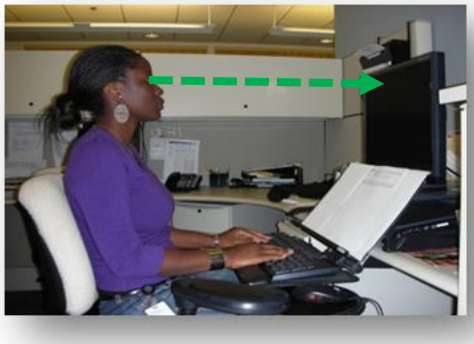
STEP FOUR: Your Monitor

Adjust your monitor screen and reference documents to position your neck in a neutral posture.

Here's what you need to do:

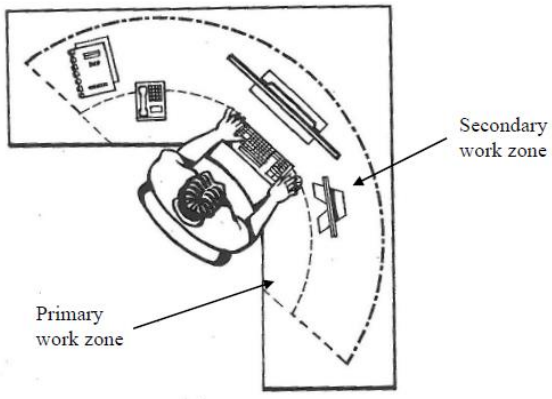
- Center your monitor directly in front of you and your keyboard so that the monitor screen is square with your shoulders.
- Sit approximately one arm's distance away from your screen.
- Position the top of the monitor approximately 5-8 cm (2-3 inches) above seated eye level. If you wear bifocals, lower the monitor to a comfortable reading level.
- Reduce glare by careful positioning of the screen.
    - Place the monitor at right angles to windows.
    - Adjust the screen angle to minimize glare from lighting.
    - Other techniques to reduce glare include glare filters.





<u>Organizing the desk top</u>

Organize the work materials and accessories into primary and secondary work zones to improve efficiency, create more working space and reduce the distance and frequency of reaches.



Consideration should be given to the following:

- Place items used frequently or for long periods in a semicircle in the primary work zone (usual work area), no further away than the distance between the elbow and knuckles when seated and upper arm is close to the body.
- Place items used occasionally or for short periods in the secondary work zone, up to one arm length away when in a seated position.
- Place materials and equipment used very seldom in the area beyond the secondary zone.

Telephones and headsets

Telephones should be positioned within the primary work zone to reduce repetitive reaching if they are used frequently.

Telephone headsets should be used when there is sustained phone use or workers are required to write or use the computer at the same time. Wireless headsets or appropriately corded headsets allow the user to stand up and move around their work station at suitable times during or between phone calls.

Laptop computers

Laptop computers are designed for short-term or mobile use. They are very convenient but can challenge good working postures.

When using a laptop for significant periods, or when being used as a desk top replacement, use separate components (full sized peripherals) that allow for better posture and can be independently adjusted. Components include docking stations, external monitors, external keyboard and mouse, laptop stands.

How to improve lighting and minimize glare

Good lighting allows users to view the screen and document easily without using awkward postures or straining the eyes from glare, shadowing or reflections on the screen. Check lighting levels and lighting distractions at various times throughout hours of operation.

Lighting levels

Consideration for lighting includes:

- higher lighting levels are required for writing and reading tasks, particularly more detailed work;
- lower lighting levels are may be suitable for tasks that are predominantly computer based;
- keep lighting levels similar for work area and general environment; and
- clean and maintain fluorescent tubes and light fittings regularly to help maintain lighting levels.

What is glare?

Glare may be experienced by light shining directly into the eyes or reflected from other surfaces such as the screen, desktop or walls. This can cause eye fatigue and headaches. With the increasing size of monitors, the larger surface areas of these monitors may increase reflected glare.

Ways to avoid glare:

- position the computer workstation so that the users' line of sight is parallel to the window;
- try to locate computer workstations between rows of overhead lights;
- control natural light from the windows e.g. use venetian blinds (best angled up rather than down);
- ensure all work surfaces and office fittings have non-reflective surfaces;
- adjust the angle of the screen so that it is 90 degrees (a right angle) to the work surface;
- avoid tilting the screen towards the ceiling;
- adjust brightness and contrast on the monitor;
- use a light-colored background on the monitor; and
- reposition the monitor and keyboard to minimize amount of glare on equipment.

Ways to reduce shadowing/ improve low light levels include:

- remove barriers to light falling on the work area, such as overhead shelving to reduce shadowing;
- adjust the brightness of lighting;
- redirect available lighting;
- maintain lights in good working order including replacing broken or flickering lights as soon as possible;
- reposition the workstation; and
- provide supplementary lighting e.g. desk lamp:
    - place the lamp to the left if right handed so the lamp light shines in front from left to right;
    - place the lamp to the right if left handed; and
    - avoid placing desk lamps directly in front of the user.

STEP FIVE: Microbreaks

Once you have correctly set up your computer workstation, use good work habits. Even in the perfect environment, prolonged, static postures will inhibit blood circulation.

Here's what you need to do:

- Remember the 30:30 Rule. For every 30 minutes to 1 hour of computer work, take a 30 second to 1 minute break.
- Build task rotation into your daily activities to include 5 to 10 minutes of non-computer work for every 1 hour of computer work.
- Avoid eye fatigue by resting and refocusing your eyes periodically. Look away from the monitor and focus on something in the distance.
- Do stretching exercises – additional exercises available in Appendix 1.



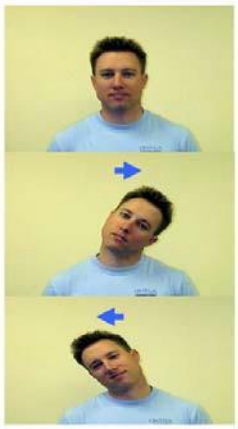

Appendix 1 – Stretching Exercises

Regular stretching exercises can be helpful in preventing musculoskeletal disorders caused by ergonomic risk factors. When done in conjunction with reducing or eliminating these risk factors, stretching can be highly beneficial.

Deep Breathing - While standing, or in an otherwise relaxed position:

- Place one hand on the abdomen and one on the chest
- Inhale slowly through the nose
- Hold for 4 seconds
- Exhale slowly through the mouth
- Repeat

1. Cervical (Neck) Retraction
Duration of Stretch = 15 repetitions of 2 seconds, total of 30 seconds.
Action
Gently pull your head back towards your shoulders. Keeping your face level, without looking up or down, move your neck forward, then bring it straight back as if it were on railroad tracks. You should feel like a turtle pulling his head back into his shell. Complete this action 15 times, holding the posture for 2 seconds each time.



2. Cervical (Neck) Side Bend
Duration of Stretch = 30 seconds – each side
Action
Tuck your chin back slightly, as in exercise #1, and then tilt your head so that your ear moves toward your shoulder. Move it to the point where you can feel a comfortable stretch in your shoulder. Make sure you do not rotate your head while tilting or raise your shoulder toward your head. Repeat this stretch on the other side.

3. Cervical (Neck) Rotation
Duration of Stretch = 15 seconds – each side
Action
Keeping your neck, shoulders, and trunk straight, turn your head slowly to the left. Move it gently to the point where you can feel a comfortable stretch. Move it back to the forward position. Relax. Then move it to the right. Complete 1 repetition on each side.

4. Back Bend
Duration of Stretch = 15 repetitions of 2 seconds, a total of 30 seconds
Action
Place your hands on your hips with your feet shoulder width apart; slowly lean backwards and look forward, hold for 2 seconds and release slowly. A mild, comfortable stretch should be felt through your low and mid-back. Complete 15 repetitions.

5. Hip Flexor with optional Chest Stretch
Duration of Stretch = 30 seconds – each leg
Action
Keeping the back leg **straight**, slowly lean towards the front knee of your forward leg. Keep your upper body centered between your legs. Contract (tighten) your stomach muscles and keep your low back straight. A comfortable stretch should be felt in the upper quad and hip. Hold this position for a count of 30 seconds, then perform this same movement on the opposite side.
Advanced Action
Simultaneously, raise your arms to achieve a 90 degree angle. Pull your upper arms back until you feel a light stretch in the chest muscles.

6. Hamstring Stretch
Duration of Stretch = 30 seconds – each leg
Action
Keep front leg straight, hands on the leg for stability (thigh). Push bottom down and out to feel stretch in back of knee (straight leg). Point the toe of the straight leg upward to increase the stretch.

7. Side Lunge
Duration of Stretch = 30 seconds – each side
Action
Lunge toward one side. Focus on the stretch in the straight leg. Hold stretch. Repeat on opposite leg.

8. Calf Stretch
Duration of Stretch = 30 seconds – each leg
Action
Leaning towards the wall, or partner, using both hands for support. The leg with the calf to be stretched is extended behind the torso while the opposite leg is placed forward with the knee bent. Keeping the back leg **straight**, slowly lean towards wall allowing front knee to bend. A comfortable stretch should be felt in the calf of the rear leg. Hold this position for a count of 30 seconds, and then perform this same movement on the opposite side.

9. Wrist Stretch
Duration of Stretch = 15 seconds – each arm - total of 30 seconds.
Action
Place your left hand on your right palm. Gently push your right hand backward as you stretch your elbow out straight. Hold for 15 seconds. Release your hand gently. Repeat on the other arm.

10. Scapular Retraction (Shoulder Blade Squeeze) – Thumbs Backward
Duration of Stretch = 30 seconds.
Action
Stand up straight with feet shoulder-width apart and arms extended outward at the sides and point your thumbs backwards. While exhaling, gradually pull arms back as far as you can, squeezing shoulder blades inward while standing and keeping arms horizontal. Hold the stretch for 30 seconds.

11. Trunk Side Bend
Duration of Stretch = 30 seconds – each side
Action
Stand with your feet shoulder-width apart, knees slightly bent and stomach contracted. Reach your arm up and over your head and lean to one side. Let your body lean into the stretch. Return to your starting position. Lean to the other side. You can also do this exercise without a rope or pole. If you are performing the stretch without a device, place the hand you are not reaching with on the side of the knee for the leg you are leaning towards.

12. Elbow Stretch
Duration of Stretch = 30 seconds.
Action
Hold your arm with elbow bent 90 degrees and fingers closed with your palm out, as if you were looking at a wrist watch. Tip your fist towards your palm and extend your forearm. Release slowly and shake hand loosely. Repeat with other arm.

Document History

REV	DATE	PREPARED BY	DESCRIPTION
New	August 2021	John Tran	