1. Introduction

The pages that follow, describe how OMSI’s Chemistry Lab is set up. Where appropriate, there will be comments about how to adapt our lab structure to another setting and also about which parts of our lab we consider essential and which parts are optional. Use this as a guideline—this setup is what has worked for us. The exact requirements and structure for the lab will need to be individualized to each new setting. Constraints of funding, space, staff time, and personal preference may limit what you are able or inclined to do.
2. The Physical Environment

a. Layout of the Lab

OMSI's Chemistry Lab is a large room (approximately 35 feet by 35 feet square) located off the Turbine Hall (one of the museum's main exhibit halls). In addition to the lab itself, there is an adjoining chemical storage room and a staff office (both rooms are approximately 8 x 15 feet).

During the construction and furnishing of the lab, an effort was made to make the space inviting and non-threatening to visitors. This was accomplished in several ways. We used green-colored counters instead of the black, industrial-looking counters. We installed several glass-fronted cabinets so that the contents are visible and less mysterious. The experiment benches are gently curved instead of being rigid rectangles. The walls are covered with colorful, non-technical-looking posters. The public copy uses an open, friendly font and has colorful graphics.

Access to the Turbine Hall is through one set of double doors and an additional single door. The doors and the wall along the Turbine Hall have large glass windows that provide visitors a view of the lab even when it is closed. Opposite the entrance, the lab has several windows that look out onto the Willamette River. The lab can be separated into three basic areas: experiment benches, display counters, and staff prep areas.
The six experiment benches are arranged in a "C" shape in the middle of the lab. Visitors access the experiments from the outside of the "C", while staff can access experiments from inside it. This arrangement allows the staff quick and easy access to all of the experiment benches. Extra supplies for the experiments are stored in cabinets under each bench for convenient restocking during the day. One of the experiment benches is accessible to visitors in wheelchairs. (Consult the Americans with Disabilities Act (ADA) for appropriate dimensions.)
Each experiment bench is equipped with a small sink and a gas valve. A strip of electrical outlets runs along the back (the staff side) of each bench. Stools for visitor use are arranged in front (the visitor side) of the benches. An outward curve on the front of each bench allows three to five visitors to interact with each experiment.

Having at least one sink for every two experiment benches, and preferably one sink per bench, is strongly recommended. Facilities for paper towels and hand soap should be next to each sink. (Visitors are asked to wash their hands and rinse equipment after each experiment so the sinks are heavily used.) Ample electrical outlets for each bench are also essential. The gas outlets are necessary only if you are doing experiments requiring Bunsen burners. Make sure there is enough space for people to sit and work at the experiment benches as well as for people to walk past them (at least four feet). (Note: It is much easier to install items such as sinks, electricity, and gas when you are first constructing the space than it is to retrofit them in later.)

Two walls along the perimeter of the lab are lined with counters for side display activities. These counters are all lined with electrical outlet strips providing ample and flexible access. Storage cabinets are located under the counters. Above the counters in the northwest corner are glass-fronted display and storage cabinets. The walls around the lab have space for posters. The front counter is visible through the window from the Turbine Hall and serves as advertisement for the lab. This space is used for enticing displays (e.g., the CO₂ Shower and Guanine Crystals) that will pique visitor interest and bring people into the lab.
The main staff prep area consists of a long counter along one wall with two large, deep sinks, under-counter cabinets, a dishwasher, a tall storage cabinet, and a water deionizer. This area is used for washing dishes, preparing solutions, developing new activities, and fixing broken activities.

The center of the lab also contains a U-shaped counter for staff use. This counter contains a sink, storage cabinets and shelves, and a chemical fume hood. This area is used mainly for demonstrations, due to its central location and visibility. It also serves as the communication hub of the lab. This is where the staff logbook and the Operating Guides for the activities are stored.

In the staff prep areas, as in the experiment benches, a large number of sinks is highly recommended. At least one large, deep sink is important for washing large items. Ample electrical outlets are also a must for electric balances, hot plates, stirrers, etc. A dishwasher is a useful accessory but not a necessity. (Consideration should be given to extra space for drying glassware if there is no dishwasher.)

The staff prep area could be housed in an adjacent room rather than in the lab itself. However, visitors are curious about what the staff is doing, and the staff prep adds another dimension to their experience in the lab. The location of the staff prep area also allows staff to keep an eye on the experiments while they are preparing solutions, etc. (Otherwise, prep must be done by an additional staff person or during hours that the lab is closed.)

Visitors enter the lab through the double doors from the Turbine hall. As they enter, they see the safety goggles and lab aprons directly ahead of them. Behind the counter with the goggles is a staff prep area and the lab’s fume hood. To their left are more staff prep areas and the safety shower. To their right are the display counters and experiment benches.
All the counters in the lab should be made of a durable material that is chemical-, scratch-, and stain-resistant (ours are a heavy-duty laminate). A dark-colored counter (ours is dark green) is recommended because it hides stains better. Multiple surface options are available, and the surface you chose will depend on your particular needs and budget.

Storage cabinets in the lab are vital. Storage is needed for general supplies and equipment as well as for experiments and activities not currently in use.
b. General Supplies and Equipment

The lab contains several pieces of permanent equipment plus a large inventory of equipment and supplies for general use. The major pieces of equipment are described individually and the simpler items are listed at the end of this section.

**Water Deionizer:** The water deionizer is not essential but is very useful. Many solutions and activities require deionized or distilled water. Using the deionizer is more convenient and ultimately cheaper than buying bottled water. If you have the funds and the space, a distiller can be added to the deionizer for increased water purity. Many other areas in the museum (e.g., the Life Science Lab) have a use for deionized water, and so our deionizer serves also as a resource for other parts of the museum.

**Fume Hood:** The chemical fume hood is another optional item. Several demonstrations and some experiment preps require use of the hood and it is a useful item to have in the museum in general. If you choose not to install a fume hood, you should not perform certain demonstrations and should buy certain solutions already prepared (e.g., 1M hydrochloric acid (HCl)). To properly install the hood, you need to adequately vent it to the outside. Check with your museum's safety officer or OSHA (Occupational Safety and Health Administration) on how to install it properly.

**Safety Equipment:** Required safety equipment is installed around the lab. (See the Chemical Hygiene Plan, section (3.b.), below, for more details.)

- There is an emergency shower and eyewash station, which needs to be unobstructed and accessible by young children.
- Three fire extinguishers distributed around the lab, are attached to the walls with brackets.
- Two fire blankets are also attached to the walls.
- A thoroughly stocked first-aid cabinet is attached to the wall behind the safety shower.
- Emergency spill boxes are kept stocked and easily accessible in several parts of the lab.
- Specially marked boxes are available for depositing broken glass (these are located out of reach of young children).

**Germicidal Cabinet:** On the counter next to the safety goggles, we have a UV germicidal goggle cabinet. The cabinet will destroy 99% of germs on forty pairs of goggles in five minutes. We run the cabinet as needed throughout the day to provide each visitor with a sanitary pair of goggles. You can also sanitize goggles by hand-washing them with a bacteriological cleaner; however, the germicidal cabinet is much more efficient and allows us to have a smaller stock of goggles.
**Appliances:** There are several small but essential laboratory appliances: hot plates, magnetic stirrers, and electronic balances. A combination hot plate and stirrer is also very useful. We have four hot plates, one hot plate/stirrer, two stirrers, and three electronic balances. Having at least two of each of these is recommended so that you can do multiple displays or preps and have backups for when equipment needs repair.

**Microscopes:** Three stereo-microscopes are available for use with several activities. Due to the frequency of repair needs, it is important to have more than one scope. Spending extra money to buy a sturdy, durable scope with as few moving parts as possible will limit breakdowns. Cheaper scopes will rapidly break under heavy visitor use.

**A-V Equipment:** A computer with a CD-ROM drive is available for visitors to explore various chemistry-related software. In addition, there is a video disk and VCR for viewing chemistry materials. These are optional equipment. We find them useful for staff, volunteers, and visitors who want more information. OMSI's computer and A-V equipment are all on carts to allow easy mobility. Consideration should be given to providing space for this equipment to be used by staff and visitors. It is important that all electronic equipment be kept away from water and chemicals.

**Sign:** There is a neon “OPEN” sign in the window of the lab. We have found this to be very useful for attracting people to the lab when the lab is open.
Other Supplies: The following list contains other general supplies that we find useful and/or essential to our lab.

- All-purpose spray cleaner
- Aluminum foil
- Aprons
- Balloons (8- or 9-in.)
- Batteries (6-volt lantern)
- Beakers (glass, various sizes, 50 ml-1000 ml, 5 to 10 of each size)
- Beakers (plastic, various sizes, 50 ml-1000 ml, 5 to 10 of each size)
- Blender (optional)
- Bottles (glass, various sizes, 125 ml-1000 ml, 5 to 10 of each size)
- Bottles (plastic, various sizes, 125 ml-1000 ml, 5 to 10 of each size)
- Broom
- Buckets (2 to 3)
- Bunsen burner (2 to 3)
- Butane lighters (for barbecue grills; keep 3 on hand)
- Candles (votive; keep 5 to 10 on hand)
- Clocks (small desk clocks with second hands, 3)
- Detergent (dishwasher)
- Drying racks
- Dustpan and brush
- Electronic calculator
- Erlenmeyer flasks (glass, various sizes, 50 ml-1000 ml, 5 to 10 of each size)
- Eyedroppers (glass, 5 to 10)
- Filter paper (large, round; keep 50+ sheets on hand)
- Floor mop
- Folding step stool
- Food coloring (blue, yellow, red)
- Funnels (glass and plastic, various sizes, 5 to 10 of each size)
- Glass cleaner
- Glass stir rods (10 to 20)
- Gloves (heavy-duty vinyl, 4 pairs)
- Gloves (latex; keep 2 boxes on hand)
- Gloves (thermal, 2 pairs)
- Glue (wood, hobby, and super-)
- Goggles (chemical safety; keep 40+ pairs on hand)
- Graduated cylinders (glass and plastic, various sizes, 10 ml-1000 ml, 3 to 10 of each size)
- Jars (glass, various sizes, 5 to 10 of each size)
- Kitchen strainer (mesh)
- Knives (sharp, 2)
- Lab wipes (keep 3 boxes on hand)
- Magnifying glass (small, plastic, 8)
- Matches (large kitchen; keep 2 boxes on hand)
- Measuring cups (1/4- to 1-cup size, 2 of each size)
- Measuring spoons (1/4-tsp to 1-tbsp size, 3 of each size)
- Mortar & pestle (large)
- Paper towels (keep 10+ rolls on hand)
- Pens and pencils (keep 10+ on hand)
- Permanent markers (several colors; keep 3 of each color on hand)
- pH paper (wide range; keep 2 rolls on hand)
- Pinch clamps (2 to 3)
- Plastic jumbo pipets (keep 100+ on hand)
- Plastic wrap
- Pocket pH meter (0.1 pH accuracy; keep 2 on hand)
- Resealable plastic storage bags (1-qt and 1-gal size, keep 25+ on hand)
- Rubber stoppers (size 00 to 10; keep 5+ of each size)
- Rubber tubing (keep 6 ft on hand)
- Rulers (3 to 5)
- Scoops (10 to 20)
- Soap (dish; keep 2 bottles on hand)
- Soap (liquid hand; keep 1 gal on hand)
- Sponges (keep 20 on hand)
- Steel wool (keep 1 bag on hand)
- Stir bars (magnetic, 10 to 15, various sizes)
- String
- Tape (labeling, various colors and widths; keep 2 rolls of each color on hand)
- Tape (transparent, masking, electrician’s, and duct; keep 2 rolls of each type on hand)
- Test-tube clamps (3 to 5)
- Test-tube racks (for various-sized tubes, 3 to 5)
- Test tubes (various sizes, 10 to 15 of each size)
- Timers (60 min, manual or digital, 2 to 3)
- Trays (cafeteria type, 10 to 15)
- Tubing (dishwashing size; keep 5 on hand plus one for each experiment)
- Two-way radio
- "Wet Floor" signs
- White vinyl mats (to line trays; keep 10 clean mats on hand)
- Wooden splints (keep 50 on hand)
c. Chemical Storage

For safety purposes, all chemicals used in the Chemistry Lab are stored in a separate, specially well-ventilated room. For security and safety purposes, access to this room is limited to as few people as possible. As added precautions, the door is locked at all times, and a safety hazard identification plaque is affixed to the outside of the door. (See OSHA or the fire department for determination of the appropriate plaque.)

Several earthquake-stabilized cabinets for storing chemicals are inside the room. There are separate flammables and acids cabinets, and other chemicals are separated from each other and stored by appropriate category (see Chemical Storage Plan, below). The Chemical Storage room also contains a refrigerator for storage of chemicals only—NO food.

Below is OMSI's Chemical Storage Plan. Check with your museum's safety officer or with OSHA for guidelines on setting up your own storage space.
OMSI's Chemical Storage Plan

1. **Inventory:** An updated inventory of chemicals (and their locations) is kept just inside the chemical storage room. Stored chemicals should be examined annually for replacement, deterioration, and chemical integrity. The list will be updated as new chemicals are ordered and as old ones are used or disposed of.
   
a. Add new chemicals to the list when they come in. (Initial and date the receipt of chemicals in the order book.)
   
b. Remove chemicals from the list as they are used.
   
c. Once a month, go through the chemical inventory to make sure the list is up-to-date and that the chemicals are in the proper location.
   
d. A yearly gross inventory shall be conducted by the Safety Manager to document reportable quantities of hazardous materials to the State Fire Marshall.

2. **MSDS:** The MSDS (Material Safety Data Sheets) for all chemicals will be stored in the Chemistry Lab office.
   
a. All chemicals in the storage room need to have all MSDS on file. The MSDS for the chemical must be the one that was made by the manufacturer of that chemical.
   
b. Keep the MSDS files updated in conjunction with the chemical inventory.

3. **Storage:** Chemicals shall be stored in their original labeled containers in the proper location. All chemicals that come into the storage room can be classified and stored in one of the categories below. Read the hazards on the container and refer to the MSDS for that chemical to determine the best place. In the case of a chemical that has several hazards listed, look and see whether the MSDS has a preference; otherwise, go with the most dangerous rating listed.
   
a. **Flammables:** Flammable chemicals and materials shall be stored in the Flammable Cabinet away from ignition sources and away from oxidizers.
   
b. **Oxidizers:** Oxidizers shall be stored in an appropriate labeled cabinet away from flammable materials.
   
c. **Inorganics:** All inorganics (metal salts and other non-organic compounds) shall be stored alphabetically in a labeled cabinet.
   
d. **Organics:** All organics (molecular, carbon-based compounds) shall be stored alphabetically in a labeled cabinet.
   
e. **Toxics (Poisons):** Poisons shall be stored in an appropriate labeled cabinet. Use of poisons shall be extremely limited.
   
f. **Acids (Corrosives):** Acids shall be stored in the Acid Cabinet away from reactive chemicals such as bases (caustics).
   
g. **Bases (Caustics):** Bases shall be stored in an appropriate cabinet away from the acids.
The Physical Environment

h. **Indicators:** Small quantities of chemicals used as indicators shall be stored in a labeled cabinet.

i. **Explosives:** Explosives shall not be stored or used in the chemistry lab.

j. **Refrigerator/Freezer:** Some chemicals (e.g., hydrogen peroxide \( H_2O_2 \) or amylase enzyme) may need to be stored in the refrigerator or freezer due to a perishable nature.

4. **Storage and Handling Guidelines:**

   a. Label all chemical solutions with the identity of the contents, date, concentration, hazard information, and name of the person who prepared it.

   b. Date label all chemicals with the purchase date. This will allow anyone to determine the age of a substance at a later date.

   c. Store chemicals in the separate, locked, dedicated storeroom.

   d. Do not allow incoming shipments of chemicals to be opened and transported by personnel other than qualified staff.

   e. All chemicals should be stored in chemically compatible families (see section 3, above).

   f. Store the minimum amount of hazardous or perishable chemicals needed.

   g. No flammable materials should be stored outside an approved flammables storage cabinet unless in safety cans.

   h. Do not store chemicals under the fume hood.

   i. If possible, keep delicate or hazardous items in the original shipping package, e.g., acids and bases in the special and expensive Styrofoam cubes.

   j. Avoid storing chemicals on shelves above eye level.

   k. The storage area and cabinets should be labeled to identify the hazardous nature of the products stored within. This will allow fire department officials to quickly see a potentially hazardous area. The National Fire Protection Association 704 placard shall be placed and maintained on the door of the chemical storage room.

   l. Shelving above any work area, such as a sink, should be free of chemicals.

   m. Shelving sections should be secured to walls or the floor, to prevent tipping of entire sections.

   n. Shelves should be equipped with lips to prevent products from rolling off.

   o. Chemicals should not be stored on the floor except in approved shipping containers.

   p. Storage areas should be ventilated by at least four changes of air per hour. Isolate the chemical storage exhaust from the general building ventilation system.
q. Never store food for consumption in the laboratory refrigerator.

r. Only authorized personnel are allowed in the chemical storage area. Untrained staff or volunteers should never be allowed in this area.

s. Exposure of chemicals to heat or direct sunlight should be avoided.

t. Refer to the MSDS and other references (e.g., the Flinn catalog) for possible hazards of chemicals before trying any procedures.

u. Consult with the Chemical Consortium at Portland State University and with the Safety Manager for hazardous waste disposal.
3. Running the Lab

a. Standard Operating Procedures

Trained staff is essential to operate the lab. For safety and liability reasons, a trained, paid staff member must be present whenever the lab is open to the public. Volunteers, however well trained and responsible, can only augment the paid staff person. Volunteers are not allowed to run the lab on their own. Likewise, the lab can never be left unsupervised when visitors or volunteers are present. To keep the lab secure, the number of people with keys to the lab should be limited.

Staff members should have some experience with chemistry and laboratory procedures. A thorough chemistry knowledge is helpful but not required. An effort should be made, when you are staffing the lab, to have a diverse group of people. Women and minority staff members are particularly important as role models.

The lab’s hours of operation are determined by the museum’s hours and available staffing. It is important to allow at least one hour prior to opening the lab and one hour after closing the lab for setup and cleanup. Because the lab is staff intensive, consideration should be given to scheduling during peak visitor attendance times.

Staff time is needed for training, scheduling, working with interns, ordering and inventorying, maintaining equipment, working with school groups, and overseeing safety concerns. Therefore, it is important to designate a Lab Director to oversee these tasks. At OMSI this job requires at least a half-time commitment. The tasks of the Lab Director could potentially be split between two or three staff members working closely with each other.

The lab is designed to operate on a basis of rotating thematic units. Each week the thematic activities are changed. This changeover process requires one to three hours. (See the following pages for guidelines for packing up a unit and preparing for the next unit.)

Each morning, the staff sets up the experiments and displays for the current unit. When the lab is open to visitors, the staff maintains the supplies for each activity, performs demonstrations, and assists visitors as needed. Each individual activity has detailed staff instructions, called an Operating Guide, on how to set up and run the activity. Checklists for unit-specific special daily procedures are included with each unit. In addition, there are general tasks that need to be done daily for all units. (See the following pages for general procedures checklists.) All checklists are specific to OMSI’s lab and would need to be modified for another location.
For Each Experiment:
- 1. Clean all equipment. Re-label or replace items if necessary.
- 2. If equipment is mechanical or electrical, check that it works.
- 3. Check that all materials and equipment are present. Remove any extra materials or equipment that is shared among activities (e.g., clocks, trays, etc.).
- 4. Restock consumables. Make sure we have adequate back up supplies. Prepare appropriate non perishable solutions. Order supplies (the order list is on the Chemistry Lab desk—write down what you need, how much, and for which unit it is required). Make a list of perishable consumables needed (if any) on the order list.
- 5. Make sure there is a clean, laminated Operating Guide in the experiment tub.
- 6. Make sure there is a clean, laminated Public Copy for the experiment.

For Each Side Display:
(Use the unit binder to check that all activities are stored in the appropriate unit cabinet or in a large-item storage area.)
- 1. Check that all pieces are present.
- 2. Clean and/or replace old parts.
- 3. Check that the display works.
- 4. (If appropriate) Restock consumables. Make sure we have adequate backup supplies. Prepare appropriate nonperishable solutions. Order supplies (order list is on the Chemistry Lab desk—write down what you need, how much, and which unit it is for). Make a list of perishable consumables needed (if any) on the order list.
- 5. Make sure there is a clean, laminated Public Copy for the activity.

For Each Demo:
- 1. Restock consumables. Make sure there are adequate backup supplies. Prepare appropriate nonperishable solutions. Order supplies (order list is on the Chemistry Lab desk—write down what you need, how much, and for which unit it is required). Make a list of perishable consumables needed (if any) on the order list.
- 2. Place appropriate equipment and nonhazardous supplies for each demo in the unit demo tub. Make sure there is a note on each Operating Guide indicating where the hazardous materials for that demo are stored.
- 3. Make sure there is a clean, laminated operating guide for each demo in the unit demo tub.
OMSI's Chem Lab—Daily Setup Checklist

The Lab
- Set up stools around the work stations.
- Change the door sign to reflect today’s date, unit, and lab hours.
- Empty the dishwasher. Store clean glassware and equipment.
- Set clean goggles out on the front counter.
- Make sure all work counters are clean.
- Turn on the “ChemLab” sign.

Experiments, Side Displays, Demos
- Refer to the Special Procedures checklist for this week’s unit. (Units rotate on a weekly basis, Mon.-Sun.)
- See the Operating Guide instructions for each experiment.
- Replenish chemicals and stock solutions as necessary.
- Store experiment tubs and surplus chemicals underneath the counter at each work station.
- Make copies of unit Take-Home pamphlets as needed. (Keep extra copies in the file drawer, masters in the unit binder.)
- Set up the unit activities and displays. Prepare a demo to perform during the day. (If you use the hood, clean it after each demo.)

Communication
- Turn on the walkie-talkie and ensure that it is tuned to channel 4.
- Check voicemail and E-mail for messages.
- Check the “hours open” and demo schedule on the museum lobby white board.
- Check Staff, Volunteer, and Intern schedules for the day.
- Check the “To Do” list, announcements, and recent entries in the logbook.

At Opening
- Open the double doors and turn on the “OPEN” sign.
OMSI’s ChemLab—Daily Closing Checklist

Ten Minutes Before Closing

☐ Close one door panel to signal that the lab is closing.

☐ Tell visitors that the lab will be closing in ten minutes but that they may still complete their current experiment(s).

At Closing

☐ Close both doors and turn off the “OPEN” and “ChemLab” signs.

Side Displays

☐ Refer to the Special Procedures checklist for this week’s unit.

☐ Rinse necessary equipment and pack the experiments into the tubs (see the Operating Guide instructions for each experiment). Store the tubs under the counters at the work stations or return the tubs to the appropriate shelves at the end of a unit.

☐ Wash off the trays and store them under the counters at the work stations or on appropriate shelves.

☐ Return all chemicals to the stockroom.

☐ Turn off and unplug all hot plates, stirrers, and other electrical appliances.

The Lab

☐ Put used goggles into the germicidal cabinet and sanitize them. (Wash goggles in soap and warm water as needed. Inspect for scratched, cloudy, or broken lenses as well as missing vent covers. Remove unusable goggles.)

☐ Wash appropriate lab equipment in the sink or the dishwasher.

☐ Wash and degrease countertops at work stations and around the room. Clean the display window and the area around the bubble shower.

☐ Reuse or recycle “Scavenger Hunts” and Take-Home pamphlets.

☐ Invert the stools on top of the counters.

☐ Turn off the “ChemLab” sign.

Communication

☐ Turn off the walkie-talkie and return it to the charger.

☐ Sign out any Intern leaving at the end of his/her shift.

☐ Record comments in the logbook.

☐ Order supplies and restock solutions as needed.
b. Chemical Hygiene Plan

The following pages contain the Chemical Hygiene Plan from OMSI's Chemistry Lab. This is a detailed description of our safety-related practices. This plan is specific to our lab but can work as a reference for other labs. The Chemistry Lab Chemical Hygiene Plan was developed with input from the museum's Safety Manager. This plan works in conjunction with the museum's Emergency Action Plan. Check with your museum's safety manager or with OSHA if you have questions when setting up your own plan.

Chemical Hygiene Plan

Oregon Museum of Science and Industry Chemistry Lab

I. Purpose:
The purpose of this OMSI Chemical Hygiene Plan is to provide information about basic chemical hygiene and safety precautions for training of employees and others who may work in the chemistry laboratory, so that all may work in a safe environment, and to comply with Occupational Safety and Health Administration (OSHA) requirements.

II. Applicability:
This plan applies to all paid employees as well as trained volunteers who may conduct activities in the OMSI Chemistry Laboratory.

III. MSDS:
1. The material safety data sheets (MSDS) for the chemicals used in the Chemistry Lab are located in the Chemistry Lab Office next to the chemical store room. They are stored alphabetically in two large three-ring binders. MSDS for other chemicals in the building are stored in the facility service offices.

2. MSDS shall be acquired from the manufacturer prior to acquisition of the chemical product on site. An MSDS shall be on file for each product with the same name for each different manufacturer. The MSDS shall remain on file as long as the product is on site. If the product is no longer on site, the MSDS shall be removed and filed in an “Obsolete” file and kept for a period of 30 years.

IV. Inspection and Test Procedures:

1. The safety shower and emergency eyewash shall be tested and documented weekly by the museum's Facility Services staff.

2. Fire extinguishers shall be inspected for charge and general condition weekly by the museum's Facility Services staff.

V. Cleaning Methods:

1. Safety goggles shall be cleaned in the germicidal cabinet after every use and washed with soap and water when needed.
2. Goggles shall be inspected for cracks, missing vents, and working head straps and shall be fixed or replaced as needed.

3. Counters and floors shall be cleaned of all chemical residues daily. Safety precautions on the cleaner containers shall be followed.

4. All glassware and plastic containers need to be cleaned daily in the dishwasher, or with glassware cleaner in the sink, and then dried and put into their proper storage areas.

VI. General Employee Rules and Procedures:

Note: All staff and volunteers who are to do work in the chemistry lab must have Hazard Communication Training and Chemistry Lab Training.

1. Minimize all chemical exposures.

2. Avoid skin contact with chemicals.

3. Avoid underestimation of chemical hazards and risks.

4. Wear appropriate eye protection at all times. Goggles must be worn anytime chemicals, glassware, or heat are used in the laboratory.

5. Avoid working alone in the laboratory, chemical storage, or prep areas.

6. Observe special precautions when handling flammable liquids. Never use these materials near any source of ignition, spark, or open flame.

7. Never perform a first-time chemical demonstration in front of the public. Always perform first-time demonstrations in front of other staff to evaluate the safety of the demonstration.

8. Never store chemicals over, under, or near a sink.

9. Permit only authorized and trained personnel in the chemical-storeroom.

10. All staff and volunteers must be trained on how to use all safety devices in the laboratory (e.g., eyewash, fire extinguisher, chemical spill kit, etc.) and must be able to find the safety devices quickly in an emergency.

11. Know appropriate procedures in the event of a power failure.

12. Know where and how to use master utility controls to shut off gas, electrical, and water supplies.

13. Avoid smelling or tasting chemicals.

14. Use a safety shield whenever an explosion or implosion might occur.

15. Read all chemical labels prior to use.

16. Know and understand the hazards of chemicals as stated in the MSDS and other references.

17. Staff must be trained to use protective safety equipment to reduce potential exposure, i.e., gloves, fume hood, etc.
18. Know how to properly store all chemicals in their compatible chemical families.

19. Know proper transportation and disposal procedures for chemicals.

20. Know and understand the personal hygiene practices outlined in the Chemical Hygiene Plan.

VII. General Laboratory Rules and Procedures:

1. The first-aid policy of the chemistry lab is the same as that in OMSI's emergency action plan and will be implemented by the trained staff person in the lab.

2. The laboratory should be well ventilated. (Use a ventilation fan that can move the air a minimum of eight air changes per hour.) Air for laboratory ventilation shall directly flow into the laboratory from non-laboratory areas and out to the exterior of the building. Ventilation must be checked by the museum's Facility Services a minimum of every three months.

3. Emergency communication is done with the chemistry lab’s two-way radio as well as by phone following the procedures in OMSI’s emergency action plan.

4. Do not use chipped, etched, or cracked glassware. Glassware that is chipped or scratched presents a serious breakage hazard when heated or handled. Broken and chipped glass is to be put into broken-glass boxes located throughout the room. When one of these boxes is filled, Facility Services should be notified to have the box replaced.

5. A permanent emergency eyewash is installed with the emergency shower on the south wall of the chemistry lab. Training on the eyewash is given with the initial safety training, and weekly inspections are done on the shower and eyewash.

6. In the event of an accident, fill out an accident report describing the event in detail as soon as possible.

7. Read all labels carefully—the names of many chemicals look alike at first glance.

8. Do not operate electrical equipment with wet hands.

9. There is an ABC halon fire extinguisher next to the center sink and a BC carbon dioxide fire extinguisher on the south wall near the storage room. A bucket of sand is just inside the storeroom for putting out class D fires. Fire blankets are mounted near each exit to the lab in case of an accident.

10. Access to exits, emergency equipment, and master utility controls should never be blocked.

11. The primary route of evacuation is the double doors in the lab. A secondary route is the single door at the northeast end of the lab.

12. Practice emergency evacuation plans on a regular basis.

13. Do not drink from lab glassware or other lab vessels.
14. No food is allowed in the laboratory. Do not eat, drink, or chew gum in the laboratory.
15. Do not apply cosmetics in areas where laboratory chemicals are present.
17. Do not run in the laboratory.
18. No unlabeled products should be stored anywhere in the chemistry lab.
19. Be thoroughly familiar with the hazards and precautions for protection before using any chemical. Study the precautionary label and review its contents before using any chemical substance.
20. All accidents or near accidents (close calls) should be carefully analyzed and the results distributed to all who might benefit.
22. Never perform unauthorized laboratory experiments.
23. Procedures for solution preparation described in the activity Operating Guides shall be followed. Follow safety precautions listed in the Operating Guides and in the MSDS.
24. Dilute acids and caustics by adding the chemical to water as opposed to adding water to the chemical.

VIII. Personal Hygiene Guidelines:
1. Wash thoroughly after any chemical exposure and before leaving the laboratory.
2. Never smell chemicals directly; always waft the odors to your nose using your hand.
3. Eye protection must be worn at all times. Goggles must meet ANSI Z87.1 Standard. Wear face shields when dealing with corrosive liquids (i.e., full-strength acids and bases).
4. Wear gloves that offer protection for all hazards you may find in the lab. Test for holes every time you wear your gloves.
5. Wear a respirator with the appropriate cartridge if you feel you might exceed permissible exposure limits as specified in the MSDS.
6. Wear low-heel shoes. Do not wear open-toed shoes or sandals of any kind. Always wear socks in the laboratory.
7. Always wear a full-length lab coat or a chemical-resistant apron.
8. Do not wear shorts or short skirts—legs should be covered.
9. Do not wear clothing with loose or balloon sleeves.
10. Tie back long hair.
11. Do not wear contact lenses—goggles do fit over eyeglasses.
12. Do not wear hanging jewelry.
13. Do not wear a long or loose necktie.
14. Do not wear an absorbent watch strap.

15. Inspect all protective safety equipment before use. If any is defective, do not use it.

IX. Housekeeping Rules:

1. Keep chemicals in the chemical prep and storage area. If chemicals are moved to the public lab area, they must be returned to their proper storage locations at the end of the day’s laboratory period(s).

2. Waste materials require proper containers and labels.

3. Do not store items in the fume hood. The storage of items in the fume hood is a fire hazard and decreases the efficiency of the fume hood.

4. Label all chemicals with the name, concentration, date, hazards, and name of the person who prepared them.

5. Clean up all spills properly and promptly.

6. All Work and floor surfaces should be cleaned regularly and kept free of clutter.

X. Spill and Accident Procedures:

1. Notify—Call for help from other staff or the Safety Manager on the radio.

   Evacuate—Get everyone out of the lab and to a safe location.

   Assemble—Have a staff person organize visitors and volunteers.

   Report—Fill out a detailed accident report after the emergency is over.

2. Clean up spills immediately and thoroughly using the chemical-spill kits located in the central storage shelves and in the chemical storage room.

3. A bucket of dry sand is available as a Class D fire extinguisher and to aid in providing traction on a slippery floor. The bucket is located just inside the chemical storeroom on the left.

4. Neutralizer for both acid and base spills, as well as absorbent pads, are available in the chemical spill kit in the event of a chemical spill.

5. In the case of an emergency evacuation, all staff, volunteers, and visitors should evacuate according to OMSI’s evacuation procedures. The chemistry lab should be secured by staff—closing all doors in the lab and turning off the gas jets and all electrical equipment. Notify the safety officer to have the gas shut-off valve closed from the building’s basement.

XI. Chemical Storage:

Refer to the Chemical Storage plan for guidelines on proper chemical storage.
c. Staff and Volunteer Training

The following pages give an outline of the training that OMSI gives all new staff and volunteers working in the Chemistry Lab.

CHEMISTRY LAB Training Outline:

PART 1: Introductions and Hazard Communication Training

1. Introductions (10-15 min): The chemistry lab staff is introduced with a brief description of their roles. Trainees then introduce themselves, giving their names (and school and year for youth interns).

2. Hazard Communication Training (45 min)—see handouts.

PART 2: History and Structure of the ChemLab

1. An overview of the NSF grant “Experiencing Chemistry” is presented.

2. The structure of the lab is described, including the following:
   A. Units
   B. Ongoing development
   C. Unit binders
   D. Chem lab daily log
   E. Intern logbook
   F. Ordering and Inventory

PART 3: ChemLab Safety Training (about 45 min)

1. A. Safety issues are introduced and emphasized. Volunteers are informed that they must have a paid staff person present to perform most functions.

   B. Show video: The Incident at Jefferson High.

2. Give a tour of safety features of the chemistry lab:
   A. Chem storage room. Show the organization of chemicals, inventory list, refrigerator (NO FOOD ALLOWED), flammables cabinet, acid cabinet, base storage, poisons storage, oxidizers storage, spill cleanup kits.

   B. First aid box. Show Band-Aids, burn cream, ice pack, accident report forms. Explain radio channel 1 for first aid help. Phone 4911 (OMSI’s in-house emergency number).

   C. Fire blankets. For use when a person is on fire; wrap him or her up and smother the flames.

   D. Glass boxes. All broken or cracked glass goes in the boxes—not in the trash! Clean up broken glass with a dust pan and broom not fingers or a sponge.

   E. Fire extinguishers. Show locations and use.

   F. Fume hood. Explain use. Show where the switch is.
Staff & Volunteer Training

G. Apron, goggles, and gloves. Show location and proper use. Show how to use the germicidal cabinet.

H. Location and use of spill kits, protective wear, etc.

I. Safety shower and eyewash. Show how to start and stop these. Note that the area must be kept clear of stuff for use and for drainage. Show folding step stool available for kids to use eyewash. Show mops and squeegee for cleaning up water.

J. Explain use of the radio.

3. Explain safe practices.
   A. Discuss proper clothing and protective equipment: no shorts or open-toed shoes; use lab coat and goggles; keep long hair tied back; wear gloves when appropriate.
   B. Demonstrate proper handling and labeling of chemicals. All secondary containers must be labeled. Long-term containers must have hazard labels.
   C. Demonstrate proper use of gas jets and burners.
   D. Demonstrate proper use of hot plates and stirrers.

PART 4: Lab Operations (About 45 min) (Hand out intern responsibilities sheet)

1. Daily procedures.
   A. Opening the lab: reset the counter, put away clean dishes, setup, restock, illuminate the door sign, do unit changeover day.
   B. Closing the lab: Make record counts, put away experiments, restock, clean up, unplug.
   C. How to use the deionizer, dishwasher, and balances.

2. Working with visitors in the lab.
   A. Getting to know the lab.
   B. Greetings and safety.
   C. Experiments: helping and restocking.
   D. Side displays (CO₂ shower, etc.).
   E. Demonstrations.
   F. Troublesome visitors. Field-trip groups.
   G. Interns

3. Always ask your friendly staff person for help or answers to questions!
Hazcom Training (45 min): (This training is required by the museum’s Safety Officer for anyone who will be working in the chemistry lab or in the museum as a whole. The training module is available from Facility Services.)

A. Explain why Hazcom training is necessary. Read “Right to Know” statement. Also state: “It is the policy of OMSI to provide a safe workplace for all those who perform work duties at OMSI locations. In order to reasonably ensure a safe workplace, OMSI informs all employees, volunteers, and contractors of company safety programs through employee orientation, training, and monthly Safety Committee meetings.”

B. Have trainees sign the green training register. Distribute pens and the training module sheet to all new persons and have them sign.

C. Explain that there will be an open-notes/open-handout exam at the end. Distribute paper for notes. Encourage newcomers to ask questions as you go along.

D. Briefly go over the highlighted objectives on the training module sheet: MSDS sheets (what and where), labeling of containers, safe handling of chemical products, Hazard Communication Program (in the folder), PPE (personal protective equipment), Internal Emergency response system (4911, radio channel #1), Facility Service’s role.

E. Show the Hazcom video (6 min). Tell trainees that the video is aimed at a slightly different audience but applies to all operations in the chemistry lab—we will be going over chemistry-lab-specific safety issues later.

F. Distribute an MSDS sample and an MSDS explanation sheet. Also distribute orange label sheets for trainees to share. Go over highlighted items on the sample MSDS. Explain labeling guidelines for chemistry lab.

G. Show examples of PPEs. Show the yellow Hazard ID Form (kept outside facility services). This form is used to report hazardous or potentially hazardous situations.

H. Distribute the test. Have trainees take it. Go over answers; have trainees grade their own tests.

I. Collect graded exams and signed training modules and give them to facility services to file. Collect the training register and orange label sheets and refile them in the Hazcom binder.
d. School Groups

School groups visiting the lab present extra challenges and opportunities. School groups can be divided into three main types: groups that reserve the laboratory ahead of time, groups that drop in while they are visiting the museum, and home schoolers.

Many school groups like to reserve the lab for their exclusive use. To accommodate them during the school year, we try to allow some time each day that the lab may be reserved for exclusive use. To cover staff time for school groups, we charge a $1 fee per student per hour of reserved time. We try to limit the number of students at a time to 18 (three students per experiment) and request that they are adequately chaperoned (at least one adult for every five students). We let the group know ahead of time what thematic unit will be set up so that they can prepare their classes. We also send the teacher a flyer (see following page) providing guidelines for using the lab. In addition, we encourage teachers to use our Experiencing Chemistry: Teacher Resource Guide. Because we offer multiple thematic units, classes can return to the visit the lab several times without repetition of activities.

School groups that drop into the lab during their visit to the museum often present special challenges. Usually these students (and their teachers and chaperones) have had no preparation for the lab. If the students are not adequately supervised, they can be disruptive to other visitors and to the safe operation of the lab. Chaperones are encouraged to be actively involved (see guidelines on the bottom of the teacher's flyer) and to remove uncontrollable students from the lab (they can present a safety hazard to themselves or to others). Students who are able to focus on the experiments usually have a good time and are eager to return to the lab.

Home-schooled families make very good use of the lab. The students usually do all the activities quite thoroughly and take full advantage of the weekly change in units. The students and parents often ask many questions, and it is rewarding to work with them to find the answers. Home schoolers are encouraged to come to the lab during less busy times so that they do not have to compete with large crowds for the activities and staff attention.
THE OMSI CHEMISTRY LAB

VISITING THE CHEMISTRY LAB: Chemistry experiences in the OMSI Chem Lab are the result of a grant from the National Science Foundation. Seven different units have been developed, with themes such as The Nature of Matter, Biochemistry, and Environmental Chemistry.

Chaperoned students will have the opportunity to have fun with

- Six exciting hands-on experiments with easy-to-follow instructions and explanations;
- numerous interesting and informative side displays;
- a Dry-Ice Bubble Shower (as seen on TV); and
- a follow-up take-home pamphlet with activities and vocabulary lessons to augment the unit on display at the time of your visit

WHEN TO COME: Join others in the ChemLab during public hours:
11:00 A.M. - 5:30 P.M., Tuesday - Friday
12:00 - 4:00 P.M., Saturday and Sunday
Additional public hours are available during the summer months.

HOW TO PREPARE FOR YOUR VISIT:

- If you would like to know which topics will be covered at the time of your visit, feel free to call the OMSI ChemLab prior to your visit (503-797-4506).
- Students must be chaperoned in the Lab. One chaperone per five children is recommended (especially for primary nonreaders.)
- A Teacher Resource Guide, with related classroom activities, has been developed for the Chem Lab. If you are interested in a copy of the Teacher Resource Guide, please contact us in the OMSI Chem Lab at (503) 797-4506.

1. Plan to spend at least 15 minutes in the lab.
2. Make sure all of your students enter and leave the lab with you.
3. Read the general safety instructions (posted on the wall) to your students.
4. Make sure that everyone (including chaperones) is wearing the provided safety goggles.
5. Point out the instructions that accompany each experiment.
6. Help the students read the instructions for each experiment.
7. Flag an OMSI staff member to help if the instructions are not clear or if there are problems with the equipment.
8. Direct students to clean up their space when they finish an experiment.
Running the Lab

School Groups

e. Intern Program:

OMSI's Chemistry Lab has several high school student volunteers (interns) who assist with all aspects of lab operation. Our student interns are part of our museum-wide youth program, and many of the administrative tasks associated with the interns are handled by our volunteer office. However, we have specific chemistry lab training and requirements for our interns that are separate from the rest of the museum. The following pages outline the requirements, responsibilities, and organization of the Chemistry Lab Intern Program.

THE OMSI CHEMISTRY LAB INTERN PROGRAM

The High School Internship program is an integral part of the EXPERIENCING CHEMISTRY project at OMSI. Motivated students, sophomores and older, are being selected from the Portland-area high schools to work in the Chemistry Lab. They are responsible for guiding and assisting visitors with experiments and activities, preparing and maintaining ongoing experiments, and developing and testing prototype activities. We intend to identify and encourage the interns' creative abilities, as well as their understanding of science and interpersonal skills. Student interns are also encouraged to bring fresh ideas for activities. Individual as well as supervised experimentation is emphasized.

Chemistry Lab Intern Requirements:

1. Application is open to all high school students. Home school students are also welcome.

2. The maximum number of interns the lab can sustain is 12 in the summer and 16 during the school year.

3. Interns applying for work in the chemistry lab will need to meet existing volunteer criteria for the museum. Applicants will need to demonstrate an interest in and a rudimentary understanding of natural phenomena and scientific reasoning. General course work in chemistry, including lab experience (working with glassware, balances, etc.), is a plus. In addition, consideration will be given to the interpersonal skills required for interaction with visitors.

4. Interns will be required to provide a minimum of 4 hours per week during the school year and 9 hours per week (two 4.5 hour shifts) in the summer. Responsibilities will include
   a. preparation, presentation, and explanation of experiments and other activities to the public;
   b. testing, evaluation, and development of experiments and demonstrations; and
   c. general maintenance and inventory activities in the lab.
5. Whenever possible, interns should schedule their shifts so that their hours overlap both the chemistry lab visitor hours and hours when the lab is closed to the public. The latter allows time for experiment preparation, demonstration preparation, testing and evaluation, and maintenance and inventory.

6. Procedure for intern candidates:
   a. Interview and application with Youth Volunteer Coordinator.
   b. Completion of Museum Volunteer Orientation and Turbine Hall Training.
   c. Interview with Lab Director and other Chemistry Lab staff.
   d. Completion of Chemistry Safety and Lab Procedures Training.

**OMSI Chemistry Lab Intern Program—Staff Responsibilities**

1. **Supervision:** The individuals with overall responsibility for all the interns in the chemistry lab are the Lab Director and Youth Volunteer Coordinator. During their shifts, the interns come under the immediate supervision of the educator(s) staffing the lab.

2. **Intern recruitment:** Interns are recruited primarily by the Youth Volunteer Coordinator. The Lab Director may also do some recruiting and will advise the Youth Volunteer Coordinator as to availability of intern shifts and intern requirements.

3. **Intern Training:** General volunteer training is provided by the Youth Volunteer Coordinator. Specific chemistry lab safety and operation training is provided by the Lab Director in conjunction with the educator staff.

4. **Scheduling:** During the summer months, the scheduling is done primarily by the Youth Volunteer Coordinator. The Lab Director advises the Youth Volunteer Coordinator on the scheduling during the summer and is primarily responsible for scheduling during the school year.

5. **Attendance:** The Youth Volunteer Coordinator is responsible for attendance during the summer. The Lab Director and the Youth Volunteer Coordinator are both responsible for attendance during the school year.

6. **Field Trips:** The Lab Director is responsible for planning and conducting intern field trips.

7. **Development:** The Lab Director is responsible for coming up with and directing development projects for the interns to work on. In addition, educators will come up with short-term tasks and projects for the interns.
Intern Responsibilities:

1. **Attendance** Interns are responsible for being in the lab during their scheduled shift. Interns who are unable to make a shift need to notify the Chemistry Lab office staff, at 797-4506, as far in advance as possible and make arrangements to make up the missed shift. (If shifts are continually missed without advance notice, the intern may be asked to leave the program.)

   At the end of their shifts, interns should fill out their chemistry daily logs and time sheets. (This log is needed for lab recordkeeping and for community-service verification for the schools.)

2. **Lab Familiarity** Interns are responsible for getting to know the lab. This includes learning special skills and safety procedures. This also includes doing and/or performing all the experiments and demonstrations currently in the lab. (Interns should refer to the index in the unit binder to see which activities they need to learn.)

3. **Lab Operation** Interns are responsible for assisting the educators in the lab. They may be assigned tasks by the educator or the Lab Director. Normal tasks that an intern is responsible for include these:

   a. **Opening the Lab:** Distribute tubs; set out glassware and other equipment; stock chemicals; select and prepare equipment and chemicals for at least one daily demo; prepare chemical solutions as needed; check/fix displays; unload dishwasher and put away glassware; make sure lab is clean and ready for visitors; assist educators with any additional tasks.

   b. **Running the lab:** Welcome incoming visitors; assist visitors with the scavenger hunt, goggles, and aprons; assist visitors with experiments and displays; perform live demonstrations for visitors; restock experiments as needed; clean counters and floor as needed; assist educators with any additional tasks.

   c. **Closing the Lab:** Clean goggles and glassware; put away experiment tubs; put away extra equipment; clean benches; recycle scavenger hunt and Take-Home pamphlets, assist educators with any additional tasks.

   d. **Development:** Test and comment on new additions to the lab (experiments, demos, graphics, computer programs, etc.); develop new activities as suggested by the logbook or by the educators; assist the educators with development projects on which they are currently working. (Ideas for projects can come from discussions with the Lab Director or an educator.)

   e. **Presentation:** Practice performing and presenting demonstrations to the public; formulate questions to engage visitors in experiments, displays, and demos; formulate explanations to help explain experiments, displays, and demos to visitors.