Chapter 6: Biological Hazards

Overview

While chemical hazards may be the most obvious safety concern in the science classroom, biology-related activities present their own risks. A review of the current Grade 11 and Grade 12 Biology curricula for Manitoba revealed no laboratory labs, investigations, or demonstrations that use pathogenic organisms, cultures, or plants that might cause injury or illness. However, there are many biology teachers who provide enriched study in both grades. This section discusses some biological hazards, suggests ways of reducing associated risks, and identifies official restrictions on biological materials in Manitoba schools.

Chemical Hazards in Biology Activities

Many activities in biology classes require the use of chemicals. As with any use of chemicals, accident prevention depends on assessing and minimizing risks related to the specific chemicals used.

General steps for managing risks include

- choosing the safest chemicals possible
- being aware of potential dangers
- instructing students in proper handling procedures and insisting that they are followed
- using appropriate protective equipment when required

See Chapter 9 for more information on selecting, storing, and using chemicals.

Accidental Infections: Specimens and Cultures

The most frequent known causes of laboratory-acquired infections are oral aspiration through pipettes, animal bites or scratches, and contact with an animal. Other common causes include cuts or scratches from contaminated glassware, cuts from dissecting instruments, spilling or dropping cultures, and airborne contaminants entering the body through the respiratory tract.

> Oral aspiration of any fluid MUST NOT BE DONE in a laboratory setting.

Use of Human Tissue and Fluid Specimens

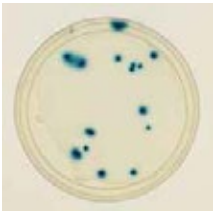
The potential risk of transmitting hepatitis or HIV (human immunodeficiency virus) through the extraction and analysis of samples of human fluid or tissue has led to the complete elimination in Manitoba schools of these experiments or demonstrations. This prohibition applies to all activities involving extraction of human tissue and fluid samples, including cheek cells, blood, saliva, and urine.

Alternative materials that schools may want to consider in place of these samples include prepared slides and simulated urine and blood. These materials are available from scientific and educational suppliers. There are also excellent videos, computer software, and Internet resources available on these topics. In addition, Canadian Blood Services can visit schools and conduct safe blood-typing activities. For further information, contact Canadian Blood Services or email <whatsyourtype@blood.ca>.

Cultures

Most micro-organisms are not harmful to humans and can be safely cultured. However, culturing harmless micro-organisms still has the potential risk of unintended contamination by pathogenic forms that may be simultaneously introduced to the culture plate. Although the body can routinely destroy small numbers of these pathogenic forms, it may be overwhelmed by large numbers. Teachers can reduce this risk by being aware of the hazards presented by infectious agents and their possible sources, and by using proper handling, storage, and disposal techniques when working with cultures.

Figure 7 ***Micro-organisms***



Some general practices to consider when culturing micro-organisms include the following:

- Do not intentionally culture anaerobic bacteria or pathogenic organisms. Pathogenic organisms can be bacteria, viruses, fungi, or protozoa.
- Select materials for study that reflect student and teacher skills and the needs of the curriculum.
  - At the elementary level, use only print and digital images of microorganisms, not live specimens.

- At the Middle Years level, use print and digital images and, where live specimens are to be used, select only micro-organisms that occur naturally on mouldy bread, cheese, or mildewed objects.
- In the Senior Years, use micro-organisms that occur naturally on bread, cheese, or mildewed objects as much as possible, and use other organisms with appropriate precautions. If swabs are taken (e.g., from door knobs or desks) and cultured, use precautions that allow for the possibility that some organisms might be pathogenic. Culture the plates for a minimum time period, view within a sealed container, and dispose as soon as possible in the regular garbage in a double strength or double plastic bag.

- Grow cultures only at room temperature or in the range of 25°C to 32°C.
- Incubation at 37°C encourages growth of micro-organisms capable of living in the human body.
- Use a culture medium that is properly sterilized by autoclaving to avoid contamination from other sources and to minimize the chance of culturing pathogenic forms of bacteria.
- Use disposable Petri dishes rather than glass ones. When no longer needed, the cultures and plates can be disposed of in the regular garbage in a double strength or double plastic bag.
- After inoculating the medium with micro-organisms, replace the cover and tape the plates shut. Subsequent observations can be made through the cover.

Proper procedures for cleaning a spill of a culture:

- Put on disposable gloves.
- Place paper towels over spill.
- Pour disinfectant such as 10% bleach solution on top of the towels and leave for 10 to 15 minutes.
- Wipe up the spill with the towels and discard into an airtight plastic bag or other appropriate container.
- If possible, autoclave all apparatus.

Dissection

Dissection is an integral part of biology that attracts much student curiosity and interest. Animals and/or organs for dissection come in either preserved or fresh form. Two potential hazards that exist from performing dissections are infections and accidental cuts from sharp scalpels.

Preserved Specimens

Specimens should be removed from the shipping solution using gloves and tongs, and rinsed thoroughly with water before proceeding. If smaller numbers of specimens are required, vacuum-packed specimens may be an alternative. Disposal of alcohol-based preserved specimens can be done via routine solid waste disposal (i.e., trash/local landfill).

Formaldehyde and Formalin-Preserved Specimens

Specimens sold for dissection now commonly come in an alcohol-based solution, avoiding the need to use formaldehyde or formalin. Formaldehyde and/or formalin-preserved specimens are still available but MUST NOT BE PURCHASED. Although cheaper than non-formaldehyde preservatives, the health risks and the cost to dispose of the liquids and tissues means that formaldehyde/formalin should not be in schools.

What to Do With Existing Formalin-/Formaldehyde-Preserved Specimens

Dissection specimens containing formalin or formaldehyde must not be used and need to be disposed of through a government-approved waste facility. Many schools may still have plastic containers of old preserved specimens that are likely formalin or formaldehyde. These specimens MUST be removed from the school immediately to avoid the risk of a plastic container rupturing and contaminating the laboratory.

For display specimens preserved in a formalin solution, there are chemicals that can be used to eliminate the formaldehyde, but the process is laborious and costly. It is recommended that these specimens be replaced.

Fresh Tissues

Fresh beef, pork and lamb, and fish organs and tissues are often used for dissection. Chicken, on the other hand, often carries salmonella and should not be used. Organs and tissues obtained from slaughterhouses or store meat departments will have been inspected for infectious agents. If kept refrigerated, they should be stable for 10 to 14 days. Handle as you would fresh meat.

High-risk materials, such as animal tissues that potentially carry infectious agents, are controlled by the federal *Health of Animals Act and Regulations* and in Manitoba by the *Livestock and Livestock Products Act*. Check with a local slaughterhouse at any time to determine what materials are available for dissection and what safety precautions may be necessary. Manitoba Agriculture, Food and Rural Development provides details of these and other legislative acts at <www.gov.mb.ca/agriculture/foodsafety/legislation/cfs06s02.html>.

Owl Pellets

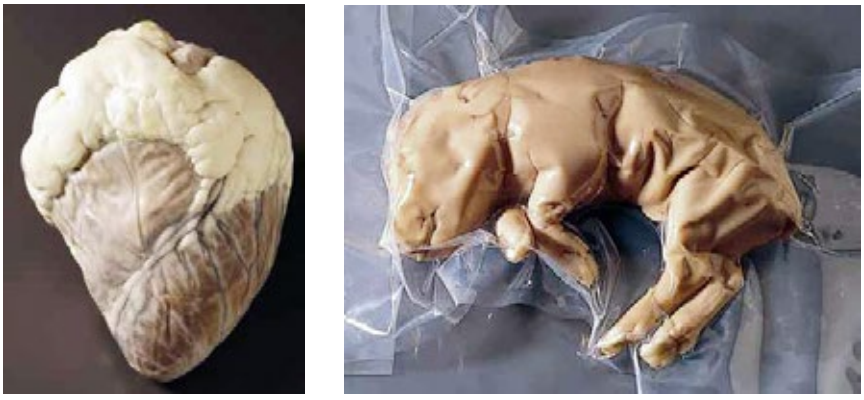
Commercially purchased owl pellets are sterilized and do not pose any infectious hazards. This will not be the case with specimens that are personally collected in the wild by the teacher or any other individual. Salmonella is a common pathogen that can be transmitted through wild owl pellets. Be aware of students who have fur allergies.

General Hazards of Equipment and Techniques of Dissection

To minimize risks during dissections, consider the following safety precautions:

- Use preserved specimens or inspected animals or animal parts. Do not use specimens preserved in formalin- or formaldehyde-based preservatives.
- Use disposable dissecting gloves.
- Whenever possible, students should use dissecting trays to reduce contaminating student work areas.
- Discard remains of fresh specimens or alcohol-based preserved specimens in double bags or double-strength bags in regular trash away from student access.
- Clean equipment, wipe lab benches, and wash hands with a commercial cleanser after a dissection.
- A 10% bleach solution can be used to sanitize student desks.

Figure 8 **Dissection Specimens**



Hazards of Activities Requiring Mouth Use

Some activities that involve the mouth include swabs in taste testing, PTC paper, spirometer mouthpieces, and plastic-wrapped thermometers. To minimize risks during these activities, consider the following guidelines:

- Avoid mouth pipetting (even if pipetting bulbs are not available), as it can result in accidental ingestion of fluid.
- Consider using tympanic thermometers, which avoids insertion into the mouth.
- Ensure that any components that are placed in the mouth are used only once, then sterilized or discarded.
- Ensure that students wash their hands thoroughly before and after each activity.
- After use, place refuse in a secured double-strength plastic bag and dispose of in a regular garbage container.

Figure 9 **Bulbed pipette**

Pipettes

Never pipette by mouth.

Pipettes are glass or plastic tubes, similar to eye droppers, which are used to transfer accurately measured amounts of liquid from one container to another. A pipette works by creating a vacuum above a liquid and drawing the liquid into the tube. Rubber bulbs (with or without valves) or specialized fillers are used to draw the liquid into the pipette. Pipettes come in several designs for various purposes and different levels of accuracy and precision. They are usually used for volumes between 1 and 100 millilitres and specialized micropipettes can measure and deliver between 1 and 1000 microlitres. Micropipettes generally have disposable, plastic tips that are ejected by a button into a waste container after each use.

Most of the danger with pipettes is from cuts and abrasions when using glass varieties. Serious cuts can occur when pipettes break while pushing them into the filler. Do not insert a pipette INTO a rubber bulb. The bulb is meant to be placed on top of the pipette, centred on the tube making a seal. If a solution is

ever drawn up into the bulb, the bulb and pipette need to be cleaned to prevent someone from contacting the solution.

Suggestions for safe use of pipettes and micropipettes:

- Use plastic pipettes instead of glass as much as possible.
- Inspect pipettes for cracks and chips and check that there is a good seal between the pipette and the pump or bulb.
- Always select the most appropriate pipette for the task.
- Wear a lab coat.
- Wear gloves.
- Wear protective glasses.
- Organize the work space so there is minimal movement during transfer of liquids.
- Carefully insert pipettes into a filler.
- Do not insert a pipette into the hole of a rubber bulb—just bring them in contact.
- Hold pipettes vertically at all times to prevent liquid from entering the filler or bulb.
- Do not pipette from a nearly empty container. This may result in liquid shooting up into the bulb or pump.
- Wipe the counter before and after with an appropriate cleaner.
- Avoid touching used tips.
- Dispose of broken pipettes in a dedicated broken glass container.

Spirometer

Teachers will often use spirometers to measure lung capacity and tidal volume. In every case, individual paper mouthpieces must be used to prevent transfer of fluids from one student to another.

Syringes

The most serious hazards associated with syringe use are accidental inoculation.

Needled syringes must not be used in science classes.

Inoculating Loops

Use care, as the film held by a loop may break and cause atmospheric contamination. A hot loop may cause a liquid to spatter when it is inserted. Allow it to cool first. A contaminated loop may produce an aerosol by boiling and volatilization when it is placed into a flame for sterilization, even before all pathogenic organisms are killed. Whenever inoculating loops are used, any actions that might result in the generation of an aerosol—jerky motions, shaking the loop, and agitating liquids—must be avoided.

Teachers should dip inoculating loops into ethanol before flaming (prevents aerosol formation).

Caution: Care must be taken because of the flammability of ethanol.

Figure 10 **Inoculating loop**

Centrifuging

Centrifuges require close monitoring to ensure the careful balancing of inserted tubes and their contents. The centrifuge lid should remain in place during the time of operation. After use, centrifuges can be cleaned with ethanol under a fume hood to disinfect the centrifuge before it is used by students again.

Gel Electrophoresis

Electrophoresis is a technique that uses electrical energy to separate molecules such as DNA and proteins by their mass and electrical charge. Electrophoresis activities may pose potential electrical, chemical, and physical safety hazards. Agarose, the most common gel medium, is considered safe but skin and eye irritation may occur. Furthermore, contamination may occur during the activity from the electrodes and other sources. The dyes used in colouring the agarose gel, however, may not be safe. Refer to the MSDS for this substance. It is not recommended to use gel media other than agarose, but refer to the specific MSDS if you do.

Electrophoresis equipment either uses batteries or power supplies. See Electrical Hazards (on page 82) in Chapter 7 for general safety measures.

Electrical shock is most likely to occur when connecting the leads in an electrophoresis apparatus.

General safety guidelines include the following:

- Turn off main power supply before connecting or disconnecting electrical leads.
- Remove jewelry.
- Wear gloves and keep your hands dry.
- Connect one lead at a time, using one hand only.
- Ensure that leads are fully seated.
- Don't run equipment unattended.
- Keep equipment clear of sinks, other water sources, or conductors.
- Turn off the power supply when inspecting or removing the gel

- Collect your gels in a leak-proof container
- Dispose of gels in double-bagged garbage bags.
- Wipe down the counter.
- Wash hands.

Plant and Animal Hazards

The study of live plants and animals in the classroom poses potential risks of injury, infection, and allergic reaction. To minimize these risks, consider the following common-sense precautions:

- Be very selective about organisms brought into the school. Check for student allergies and diseases the animal may carry.

Figure 11 **Rat**

- Consider how you will provide long-term care or dispose of the animal before acquiring it.
- Use domesticated animals or those available through reputable, licensed pet stores. Wild animals should never be brought into classrooms. (Permits may be obtained from Manitoba Conservation to collect wild fish.)
- Know and use proper handling techniques.
- Wear heavy gloves to protect against biting and scratching.
- Explain to students the importance of acting respectfully and responsibly around the animals. Ensure that students do not tease the animals or put their fingers or other objects into the cages.
- Maintain animals in a clean, healthy environment.
- Discourage students from bringing sick animals into the laboratory, and do not allow students to bring in any animals that have died from unknown causes.

When selecting plants, be aware that many plants can be poisonous or contain irritants. This includes a number of plants that are often used in the home. Make a point of checking for toxic properties of plants before using them in the classroom, and ensure that students wash their hands after handling plants or plant parts.

Figure 12 **Poisonous Plants**

Some common poisonous plants to be aware of include:

- plants poisonous to touch due to exuded oils:
  - Poison ivy (*T. radicans; R. diversiloba*)
  - Oleander (*N. oleander*)
- toxic house or garden plants:
  - Poinsettia (*E. pulcherrima*)
  - Dieffenbachia (*D. maculata*)
  - Castor bean (*R. communis*)
  - Mistletoe (*V. album*)
  - Lantana (*L. camara*, etc.)
  - Hyacinth (*Hyacinthus orientalis, Scilla nonscriptus, and Agraphis mutans*)
- other plants that are poisonous when eaten:
  - Tansy (genus *Tanacetum*)
  - Foxglove (*D. purpurea*)
  - Rhubarb leaves (*R. rhabarbarum*)
  - Baneberry (*Actaea pachypoda; Actaea rubra*)
  - Marsh marigold (*Caltha palustris*)

Cleanliness in Biology

Areas where organisms are kept or cultured must be given special attention with regards to cleanliness.

General safety guidelines to consider include the following:

- Do not store or consume food in these areas.
- Wash all used surfaces with a disinfectant (e.g., bleach) after each activity.
- Contact Health Canada, your local health authority, or a science supply catalogue for appropriate disinfectants.
- Clean shelves, cupboards, animal cages, autoclaves, fridges, and other items at weekly intervals using an appropriate disinfectant.
- Wash hands after handling any kind of organism(s).

If an autoclave is not available, sterilize equipment used in microbiology by boiling in a pressure cooker for 10 to 15 minutes. The heat provided by a microwave, on the other hand, is not uniform enough for this purpose. An ultraviolet light cabinet can be used to sterilize external surfaces. Liquid disinfectants and germicidal agents generally will not provide complete sterilization.

Figure 13 **Autoclave**

Chapter 7: Physical Hazards

Overview

Physical hazards include mechanical, electrical, heat, sound, and radiation hazards that may occur in physics laboratory activities, as well as a variety of other science activities. Hazards in each of these categories have the potential to cause injuries (or, in some extreme cases, even death), but by taking general precautions, such as using appropriate protective equipment and emphasizing routine safety, physical hazards can be easily minimized.

Mechanical Hazards

- In general, safety can be increased by ensuring that equipment is well maintained.
- Turn off all equipment before leaving the area.
- Students must only use equipment with teacher supervision.

Rotating Machinery

Machinery with rotating parts can catch loose clothing, hands, or hair, potentially causing serious injuries. Uncovered parts may also fly off, thereby creating additional risk, especially for eye injuries.

To minimize risks, do the following wherever possible:

- Ensure rotating shafts, belts, and pulleys are covered by guards, lids, or covers.
- Check devices attached to a rotor before use to ensure that they are tightly fastened.
- Wear (and have students wear) eye protection when using uncovered, rapidly rotating parts, as in the demonstration of centripetal force and circular motion.
- Have students stand back as much as possible.
- Have a safety shield available in the science area.