SC Farm Bureau

AG in the classroom

SOUTH CAROLINA Energy Office

Resources

The average person in the U.S. produces about 4.3 pounds of solid waste in a day.
(Annenberg Foundation/CPB, **learner.org/exhibits/garbage/intro.html**)

Biomass is any organic matter that can be used as an energy source.

Biomass contains little sulfur and nitrogen, so it does not produce the pollutants that can cause acid rain.

Acre facts:
43,560 sq feet = acre
4,047 sq meters = acre
An acre is about the size of a football field.

Using biomass for energy reduces the amount sent to landfills.

Garbage is one source of biomass.

A ton (2,000 lb) of garbage can contain as much heat energy as 500 lb of coal.

Landfills can collect methane gas, purify it and use it as an energy source.

Garbage can be burned to generate steam and electricity.

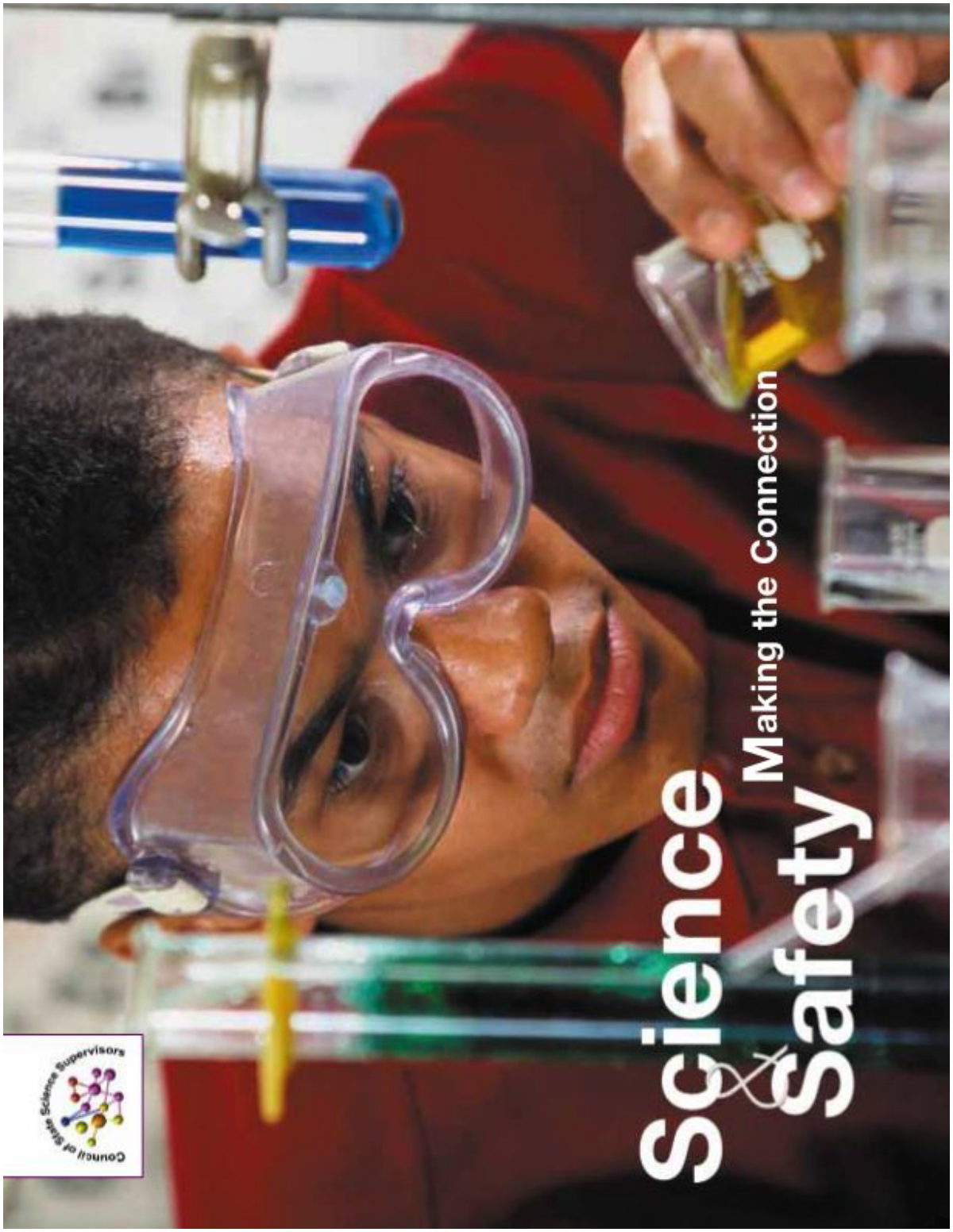
In 2000, about 44% of all renewable energy consumed in the U.S. came from biomass.	In some landfills, wells are drilled into piles of garbage to capture methane gas produced from the decaying waste.	Methane gas can be purified and used as an energy source, just like natural gas, that we burn in our stoves and furnaces.
Bacteria feed on dead plants and animals. As plants and animals decay, they produce a colorless, odorless gas called methane.	A landfill in Florence, Alabama recovers 32 million cubic feet of methane gas per day. The City purifies the gas and pumps it into natural gas pipelines.	Methane gas can cause fires or explosions if it seeps into nearby homes and is ignited.
Methane gas, the main ingredient in natural gas, is rich in energy.	New regulations require landfills to collect methane gas for safety and environmental reasons.	In China, many farmers use all of their garbage, even animal and human waste, to make methane. They put the waste into a big tank without air. It makes methane as it rots. Farmers use the gas to cook food and light their homes. The waste that is left can be used as fertilizer to grow more crops.

Power plants that burn garbage and other waste for energy are called waste-to-energy plants.	Biomass can be converted into usable energy in four ways: burning; fermentation; bacterial decay; and conversion.	Less than 2% of Americans farm for a living.
77% of biomass energy is used by industry.	Biodiesel can be made from vegetable oil, animal fat or recycled cooking oil.	Farm forest products include paper, pulp and wood used to make products such as furniture and houses.
The energy in biomass is stored as chemical energy and can be burned, or converted to methane gas or ethanol.	Americans only spend about 11% of their income for food.	Wood (logs, chips, bark and sawdust) accounts for about 79% of biomass energy.

The exhaust from biodiesel-fueled vehicles smells like fried potatoes!	Clemson University and South Carolina State University are the state's two land grant institutions.	Farmers who use crop protection chemicals are required to be trained in application methods and to keep accurate records of usage.
Biomass gets its energy from the sun. Plants absorb sunlight in a process called photosynthesis.	Agricultural biotechnology helps farmers produce healthier, pest-resistant crops that require fewer crop protection chemicals.	Biomass is an important source of energy and the most important fuel worldwide after coal, oil and natural gas.
Biodiesel has significantly improved lubricity, which can decrease maintenance costs and reduce engine wear. Even blends as low as 1% can improve lubricity by as much as 65%!	A large tractor with attachments can cost more than a house.	Using biomass does not increase the amount of carbon dioxide in the atmosphere.

Biomass produces 2% of the electricity we use (produced by electric utilities).	Biomass is called a renewable energy source because we can grow more in a short amount of time.	Biofuel blends are referred to with the initial of the biofuel, then a number indicating the biofuel percentage of the blend. For example, E-10 is a 10% ethanol blend; B-20 is a 20% biodiesel blend.
Ethanol is an alcohol fuel made by fermenting the sugars found in grains, such as corn and wheat.	Ethanol usage can reduce total carbon dioxide emissions.	Growth in biobased products will stimulate rural development efforts in farming, forestry and associated service industries.
Gasohol refers to gasoline blends containing up to 10% ethanol.	Agriculture is the number 2 industry in South Carolina, and the number 1 industry in the U.S.	Domestic bioenergy sources could help our nation to substantially reduce dependency on petroleum.

Biomass can make ethanol, a fuel a lot like gasoline. Ethanol costs more than gas to use, but it is cleaner and renewable.	Ethanol is a water-free additive that absorbs moisture and helps prevent gas line freeze up in cold weather.	
Biomass can be used to generate electricity with the same equipment or power plants that are now burning fossil fuels.		
Land not needed for food production can be used to grow energy crops.		



This science safety guide, geared to higher school grades, is available online at csss.enc.org/safetym, published by the Council of State Science Supervisors (CSSS) with support from the American Chemical Society, the Eisenhower National Clearinghouse for Mathematics and Science Education, National Aeronautics and Space Administration, Dupont Corporation, Intel Corporation, and the National Institutes of Health.

A Note to the User

With the increasing emphasis on hands-on, minds-on inquiry instruction at all levels in the National Science Education Standards (NSES) and most state frameworks or courses of study, it becomes more incumbent upon science teachers to be as knowledgeable as possible about laboratory safety issues and their own responsibilities. As science supervisors/specialists, the members of the Council of State Science Supervisors (CSSS) are constantly receiving questions from teachers and administrators about safety issues, responsibilities, and liability. This document, which addresses ten of the most commonly asked questions, is one response to those inquiries.

The goal of this document is to provide a handy, concise reference for science teachers, primarily at the secondary (9–12) level. They can refer to it for information and resources on some of the most commonly asked questions that concern science teachers. Resources cited are in paper, electronic, and Internet accessible forms. It should be clear that this document cannot be comprehensive because of limitations of the format and purpose. It is hoped that the most important information needed about the topics is incorporated. No implication of endorsement or lack of endorsement should be read into inclusion or omission of any referenced material within this document. For more information about specific questions in the document as they pertain to a particular locale or state, contact your local or state fire marshal, building commission, health department/poison control center, environmental regulatory and state Occupational Safety and Health Administration (OSHA) agency, or science specialist at the local or state board of education/education agency.

The Council of State Science Supervisors, an organization of state science supervisors/specialists throughout the United States, has a long history of working with other science education organizations and professional groups to improve science education. For more information about CSSS and its membership, direct your browser to http://csss.enc.org.

Members of the CSSS Safety Committee who developed this document are:

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DISCLAIMER: The materials contained in this document have been compiled using sources believed to be reliable and to represent the best opinions on the subject. As stated above, the goal of this document is to provide a handy, concise reference that science teachers, primarily at the secondary (9–12) level, can refer to for information and resources on some of the most commonly asked questions that concern science teachers. The document as a whole does not purport to specify minimal legal standards. No warranty, guarantee, or representation is made by the Council of State Science Supervisors or its consulting partners as to the accuracy or sufficiency of the information contained herein, and the Council and its supporting partners assume no responsibility in connection therewith. The document is intended to provide basic guidelines for safe practices and facilities. Therefore, it cannot be assumed that ALL necessary warnings and precautionary measures are contained in this document and that other or additional information or measures may not be required. It is advised that users of this document should also consult pertinent local, state, and federal laws pertaining to their specific jurisdictions, as well as legal counsel, prior to initiating any safety program. Registered names and trademarks, etc., used in this publication, even without specific indication thereof, are not to be considered unprotected by law.

What are my legal responsibilities as a science teacher relating to negligence?

The LEGAL DEFINITION of "negligence" is important for every teacher to know. Negligence, as defined by the courts today, is conduct that falls below a standard of care established by law or profession to protect others from an unreasonable risk of harm, or the failure to exercise due care. It should be noted that in the absence of specific laws or local policies, the standard of care expected is set by the profession, e.g., position statements adopted by the National Science Teachers Association (NSTA), the National Association of Biology Teachers (NABT), the American Chemical Society (ACS), or the Council of State Science Supervisors (CSSS).

The science teacher has three basic duties relating to the modern concept of negligence:

- Duty of instruction.
- Duty of supervision.
- Duty to properly maintain facilities and equipment.

Failure to perform any duty may result in a finding that a teacher and/or administrator within a school system is/are liable for damages and a judgment and award against him/them.

DUTY OF INSTRUCTION includes adequate instruction before a laboratory activity (preferably in writing) that:

- Is accurate; is appropriate to the situation, setting, and maturity of the audience; and addresses reasonably foreseeable dangers.
- Identifies and clarifies any specific risk involved, explains proper procedures/techniques to be used, and presents comments concerning appropriate/inappropriate conduct in the lab.

Instruction must follow professional and district guidelines.

Teachers who set bad examples by not following proper laboratory procedures may be sued if injury results from students following the teacher's bad examples.

DUTY OF SUPERVISION includes adequate supervision as defined by professional, legal, and district guidelines to ensure students behave properly in light of any foreseeable dangers. Points to remember:

- Misbehavior of any type must not be tolerated.
- Failure to act or improper action is grounds for liability.
- The greater the degree of danger, the higher the level of supervision should be.
- The younger the age of students or the greater the degree of inclusion of special population students, the greater the level of supervision should be.
- Students must never be left unattended, except in an emergency where the potential harm is greater than the perceived risk to students. Even then, risk should be minimized or responsibility transferred to another authorized person if the situation allows.

DUTY OF MAINTENANCE includes ensuring a safe environment for students and teachers. This requires that the teacher:

- Never use defective equipment for any reason.
- File written reports for maintenance/correction of hazardous conditions or defective equipment with responsible administrators.
- Establish regular inspection schedules and procedures for checking safety and first-aid equipment.
- Follow all safety guidelines concerning proper labeling, storage, and disposal of chemicals.

By keeping files of all hazard notifications and maintenance inspections, teacher liability in the event of an accident is minimized in cases where no corrective actions were subsequently made.

Where can I find a general science-safety checklist?

The following Internet sites and software are excellent sources for information concerning science safety:

- Flinn Scientific
  http://www.flinnsci.com/
- Sargent-Welch
  http://www.sargentwelch.com/html/safety-ck.html
- Wellesley College
  http://www.wellesley.edu/ScienceCenter/lab-safe-home.html
- Gerlovich, Jack A., et al. Total Science Safety System Software. JaKel, Inc., 1998. JaKel, Inc. Online Information Site: http://www.netins.net/showcase/jakel
- Kaufman, Jim. The Laboratory Safety Institute. Online Information Site: http://www.labsafety.org

Here is a general science-safety checklist to copy and use.

- Have appropriate protective equipment, e.g., American National Standards Institute (ANSI) Z87 or Z87.1 coded goggles, chemical aprons, non-allergenic gloves, dust masks, eyewash, shower(s), ABC fire extinguisher(s), sand bucket(s), fire blanket(s), in easily accessible locations. (General rule is accessibility within 15 seconds or 30 steps from any location in the room.) Make certain that instructor and students wear adequate protective equipment, including especially safety goggles and aprons, when experiments involving hazardous chemicals or procedures are conducted.
- Notify supervisors immediately of hazardous or potentially hazardous conditions, such as lack of Ground-Fault Interrupters (GFIs) near sinks, inadequate ventilation, or potential hazards, e.g., study halls scheduled in laboratories or tile floors not waxed with non-skid wax.
- Check the fume hood regularly for efficiency and never use the hood as a storage area. Ensure that the hood is vented properly through the roof.
- Use only equipment in good condition (not broken) and efficient working order.
- Have a goggle sanitation plan for goggles used by multiple classes per day.
- Have separate disposal containers for broken glassware or flammables.
- Discuss and post emergency/escape and notification plans/numbers in each room/laboratory. Clearly mark fire exits, and keep exits (preferably two from laboratories) unobstructed.
- Have and enforce a safety contract with students and parents.
- Identify medical and allergy problems for each student to foresee potential hazards.
- Model, post, and enforce all safety procedures. Display safety posters.
- Keep laboratory uncluttered and locked when not in use or when a teacher is not present.
- Know district and state policies concerning administering first aid and have an adequately stocked first-aid kit accessible at all times.
- Know and follow district and state policies/guidelines for use of hazardous chemicals, live animals, and animal and plant specimens in the classroom/laboratory.
- Report all injuries, including animal scratches, bites, and allergic reactions, immediately to appropriate supervisors.
- Keep records on safety training and laboratory incidents.
- Provide the number of accessible lab stations having sufficient workspace (60 square feet or 5.6 square meters) workspace per student; 5 foot or 1.5 meters wide aisles and low lab table sections for wheelchair accessibility that can be supervised by the number of qualified teachers/aides present (maximum 24:1).
- Have master cut-off switches/valves within each laboratory (preferably in one secure location); know how to use them; and keep water, gas, and electricity turned off when not in use.

- Maintain up-to-date chemical and equipment inventories, including Material Safety Data Sheet (MSDS) files.
- Label equipment and chemicals adequately with respect to hazards and other needed information.
- Post the National Fire Protection Association (NFPA) "diamond" at all chemical storeroom entrances denoting the most hazardous chemical in each category within. Regularly send an updated copy of the inventory to the local fire department.
- Organize chemical storerooms properly. Arrange chemicals by National Institute for Occupational Safety and Health (NIOSH)/ Occupational Safety and Health Administration (OSHA) compatibility classes, with special storage available for oxidizers, non-flammable compressed gases, acids, and flammables.
- Store chemicals in appropriate places—e.g., below eye level, large containers no higher than 2 feet (.6 meters) above floor, acids in corrosives cabinets, and solvents in OSHA/NFPA approved flammables cabinets—with acids physically separated from bases and oxidizers physically separated from organics within secure, limited access, adequately ventilated storerooms. Chemical shelving should be wooden, with a front lip and without metal supports.
- Provide in a readily accessible location appropriate materials and procedures for clean-up of hazardous spills and accidents, e.g., aspirator or kit for mercury spills, vermiculite and baking soda for acids, and 10% Clorox bleach solution or 5% Lysol solution for body fluids, and appropriate procedures for disposal of chemo- and bio-hazardous materials.
- Prohibit the use of pathogens or any procedures or materials in any school laboratory above Biosafety Level 1 as outlined by Centers for Disease Control/National Institutes of Health protocols.
- Keep live animals and students adequately protected from one another.

How should I label and store chemicals?

A Material Safety Data Sheet (MSDS) should be kept on file and be easily accessible for ALL chemicals. MSDS sheets should be referenced for proper storage and for appropriate personal protective equipment (PPE). Refer to your school district and state policies for local storage requirements and mandates.

Labeling Chemicals

Include the following minimum essential information on chemical labels:

- Chemical manufacturer or supplier (including address and telephone number).
- Chemical name and/or trade name of the product (same as MSDS when applicable).
- Date received or date placed in the container.
- Strength of the chemical.
- Precautions to be observed in handling or mixing the chemical.
- Appropriate hazard symbol National Fire Protection Association (NFPA) rating.

Chemical Storage

Store chemicals according to the following minimum storage requirements:

- Separate storage area from the classroom area. Use appropriate warning symbols to mark storage areas.
- Make certain that storage area is properly ventilated.
- Make certain that fire door or adequate exits are provided.
- Provide appropriate fire extinguisher(s) or extinguishing systems.
- Make certain that storage shelves are securely attached to wall (each shelf with a front one-inch or 2.5 centimeters lip to prevent bottles from sliding off shelves).
- Separate inorganic chemicals from organic chemicals.
- Use a reputable guide, e.g., National Institute for Occupational Safety and Health/ Occupational Safety and Health Administration (NIOSH/OSHA), to help you properly separate incompatible chemical families.
- Do not store chemicals past the manufacturer's suggested shelf life.
- Make certain that chemicals are labeled and stored in appropriate containers.
- Store flammables and corrosives separately in appropriate cabinets.

How should I purchase new chemicals and dispose of old chemicals?

A purchasing policy should be developed by the school/district. Before purchasing a new chemical, review the Materials Safety Data Sheet (MSDS) that will provide important information on physical properties, toxicology, storage, and handling for the chemical.

Consider these factors BEFORE purchasing:

- Will amounts be used within 1–2 years?
- Can the chemical be stored properly?
- Is the facility properly designed to use the material safely?
- Can the chemical be easily disposed of and will it be disposed of as a hazardous waste?
- Does the facility have proper personal protective equipment (PPE)?
- Are facility personnel aware of any hazards associated with this product?
- Are facility personnel properly trained in the use and handling of the material?
- Does the budget allow for disposal of the chemical or by-products?

Disposal

The Environmental Protection Agency (EPA) and the American Chemical Society (ACS) list the following possible disposal methods:

- Sanitary landfills.
- Hazardous waste landfills.
- Sewer system (regulations differ for different locations).
- Thermal treatment (incineration).
- Recycling or reuse.
- Chemical, physical, or biological treatments, including neutralization, oxidation, precipitation, and solidification.

For safe disposal of materials, consult the appropriate MSDS sheet. If an MSDS is not available, request one from the manufacturer or obtain one online at http://www.msdsonline.com. Disposing of wastes in landfills is not environmentally recommended; reducing wastes, recycling, and destruction are preferable.

If you are not sure if a waste is hazardous, contact a local/state hazardous waste management agency or your state or regional EPA office, fire marshal's office, or state department of education.

What should a chemical hygiene checklist for school science labs include?

Most states and the Occupational Safety and Hazard Administration (OSHA) require work environments, including schools, to have a safety plan that reduces risks and ensures a safe workplace for employees (OSHA Laboratory Standard—29 CFR 1910.1450). This is referred to as the Chemical Hygiene Plan (CHP) and includes policies, procedures, and responsibilities designed to develop an awareness of potentially harmful chemicals in the workplace. It is important that laboratory chemicals be used only with knowledge of possible risks involved and within acceptable limits of exposure. The CHP must stress that everyone in the school has the right to know what hazards he or she will be exposed to and is responsible for implementing safety procedures and policies. Immediate supervisors have the responsibility to provide continuing education on safety guidelines and procedures to those under their direction. The CHP should be reviewed at least annually and revised as needed.

The science department chairperson or the chemistry teacher is usually responsible for developing the CHP for the school and may share this task with the facility supervisor. Since care and supervision of the science room are primarily the responsibilities of the classroom teacher, the CHP should serve as a guide to safe science instruction. Teacher responsibilities include:

- Development of a statement that includes clearly defined responsibilities of the superintendent, principals, department chairs, classroom teachers, students, and parents.
- Inclusion of a laboratory safety program as part of the curriculum and instruction.
- Regular training for all staff on safety policies, record keeping, and other procedures.
- Evaluation of laboratory facilities and procurement of equipment needed.
- Development and enforcement of a plan for monitoring safety equipment and storage areas.
- Preparation and storage of safety records, i.e., inventories, Materials Safety Data Sheets (MSDS), accident/incident reports, hazard notification reports.
- Identification of hazardous chemicals and minimizing exposure to students and teachers, e.g., computerized/written inventory.
- Development of safety policies and procedures for procurement, distribution, storage, and disposal of chemicals, e.g., using MSDS file.
- Development of a written emergency plan and practiced procedures for spills or accidents involving chemicals.
- Implementation of a plan for posting signs and labels.

What general guidelines should I follow in case of student accidents?

In the event of accident, teachers should act promptly and decisively, following a pre-existing, approved local emergency plan that has been previously practiced! This plan might include the following general steps:

- Check the scene, assess the general situation, and take whatever immediate action is necessary to remove the hazard and prevent students from being further exposed to injury.
- Check the injured party with a quick scan to assess the severity of the injury and decide on a course of action.
- Notify school authorities (school principal and school nurse) and call 911 or other predetermined emergency or medical personnel, if injury appears to make that necessary.
- Have a properly trained person appropriately care for the injured party.
- Ensure that a parent, guardian, or designated alternate person and/or the family physician have been contacted.
- After the emergency has passed, record the facts and obtain witness reports. Provide copies of records (accident reporting forms) to an administrator and keep records on file in a safe place.

The following actions are recommended for specific emergencies. Remember, you must assess the situation and determine what is appropriate to the immediate situation. Always refer to the appropriate Material Safety Data Sheet (MSDS) for information regarding health hazards, reactivity, disposal, and personal protective equipment before using a chemical for personal or class use.

Chemical in the Eye:

Call 911 and send someone to notify the school nurse and an administrator. Flush the eye immediately with potable, aerated 60°F–90°F (15.5°–32.2°C) water at a rate of 3–5 gallons/minute (11.4–18.9 liters/minute). Hold eyelids apart as wide as possible and flush for at least 15 minutes or until emergency personnel arrive. Do NOT try to neutralize acids or bases, but wash the offending chemical out of the eye as quickly as possible to prevent further damage. If contact lenses are being worn, the water should wash them away. If the lens chemically adheres to the eye, do NOT try to remove it. Let a professional do that.

Student or Chemical/Material on Fire:

Remember a panicky student on fire will probably not be cooperative! You may need assistance from other students or faculty. If you are near an emergency shower, obtain assistance in getting the student under the drench shower and douse flames with water. If not near an emergency shower, drop and roll the student and smother the flames with a retardant-treated wool fire blanket. (Never wrap a standing student in the blanket, because this creates a "chimney" effect.)

For materials on fire, obtain the nearest ABC fire extinguisher, remove safety pin, and approach the fire. Only when 5–6 feet (1.5–1.8 meters) from the fire should you begin to discharge the extinguisher. Remember, the average fire extinguisher only operates 8–10 seconds at maximum efficiency. Take care to smother, not scatter, the burning chemical material.

Smother burning alkali metals with clean, dry sand. Keep a covered sand bucket for that purpose.

Acid/Base Spills:

Neutralize spilled acids with powdered sodium hydrogen carbonate (sodium bicarbonate/baking soda) and bases with vinegar (5% acetic acid solution). Avoid breathing vapors. Spread diatomaceous earth to absorb neutralized chemicals, sweep up, and dispose of properly.

If the spill is directly on skin, flush the area as soon as possible with copious amounts of cold water from faucet or drench shower for at least 5 minutes. If the spill is on clothing, drench with water and cut/remove the clothing to remove the chemical from contact with the skin as soon as possible. If the skin appears acid-burned, daub a paste of sodium hydrogen carbonate on the affected area and obtain medical attention as soon as possible. If the skin appears burned by a strong base, daub vinegar on the affected area and obtain medical attention as soon as possible. Do NOT cover with bandages.

Release of Body Fluids, Pathogenic Bacteria, or DNA Samples:

For cleanup of body fluids, pathogenic bacteria, or spilled DNA samples, it is imperative that gloves be worn during the cleanup. A diluted disinfectant, such as 5% Lysol, Zephiran, Wescodyne, or similar disinfectant or 10% Clorox bleach solution should be poured on the spill and worked toward the center with paper towels. The paper towels should be disposed of in biohazard bags. Contaminated glassware should be sterilized in an autoclave for at least 30 minutes at 15 p.s.i. and temperatures above 248°F (120°C).

Mercury Spills:

Retrieve mercury with an aspirator bulb or mercury vacuum device. Cover droplets with sulfur to reduce volatility.

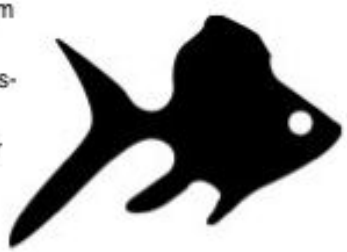
What precautions should I take when using animals or plants in the laboratory?

Animals:

Before using animals, teachers should establish guidelines to avoid any intentional or unintentional abuse, mistreatment, or neglect of animals and to promote humane care and proper animal husbandry practices. Whenever animals are to be used in science activities with students, it is imperative that care be exercised to protect both the animals and the students. If animals are to be kept for any time in the room in cages, be certain that adequately sized and clean cages are provided to all animals. Keep cages locked and in safe, comfortable settings.

Animals can stimulate and enhance learning and should be used safely in the laboratory/classroom. Because increased activity and sudden movements can make animals feel threatened, ALL student contact with animals should be highly organized and supervised. Teachers should keep the following precautions in mind to ensure an enjoyable and comfortable experience for their students.

- Inquire beforehand about student allergies associated with animals.
- Allow students to handle/touch animals only after proper directions and demonstrations have been given.
- Have students use gloves while handling vertebrates and appropriate invertebrates and wash hands afterward.
- Report to the principal and school nurse immediately any animal bites or scratches.
- Have a veterinarian evaluate all animals that die unexpectedly.
- Never dispose of fecal matter in sinks or with commonly used equipment.
- Never use wild animals. Obtain classroom animals from reputable pet suppliers.
- Never use poisonous animals in the classroom.
- Never allow students to tease animals or touch animals to their mouths.



Plants:

While plants produce the oxygen necessary for animal life, provide us with food, and beautify our surroundings, some produce very toxic substances. Teachers should familiarize themselves thoroughly with any plants they plan to use in the classroom.

- Inquire beforehand about student allergies associated with plants.
- Never use poisonous or allergy-causing plants in the classroom.
- Never burn plants that might contain allergy-causing oils, e.g., poison ivy.
- Make a clear distinction between edible and non-edible plants.
- Never allow plants to be tasted without clear direction from the teacher.
- Have students use gloves while handling plants and wash hands afterward.

What protective equipment should be kept/provided in a laboratory for teacher and student use?

The following list is excerpted from Total Science Safety System software (JaKel, Inc., 1998), with the approval of the authors.

- Master shut-off valves/switches should be located within each laboratory, preferably in one secure location accessible only to the instructor. Water, gas, and electricity should be turned off when not in use.
- Adequate numbers of tri-class ABC fire extinguishers should be strategically placed within 30 steps or 15 seconds of any location in the room. These should be checked and certified as fully charged and in working order at least every six months.
- Multiple faucet-type portable eyewash stations should be strategically placed within 30 steps or 15 seconds of any location in the room. Eyewash stations should be forearm or foot-operated for hand-free operation. Flow rate of potable water at 1.5 gallons/minute (5.7 liters/minute) at pressure below 25 p.s.i. is recommended if a standard eyewash unit is installed.
- Forearm or foot-operated face/body sprayers, with adequate flexible hoses and water pressure, should be strategically placed within 30 steps or 15 seconds of any location in the room. If a standard plumbed safety shower unit is used, it should provide potable water at a flow rate of 30–60 gallons/minute (113.6–227.2 liters/minute) at a pressure of 20–50 p.s.i.
- An appropriate fume hood, vented through the roof to at least 8 feet (2.4 meters) above the roof line, should have a face velocity of 60–100 feet/minute (18.3–30.5 meters/minute) of air through the hood. The hood should not be within 10 feet (3.1 meters) of an exit or on a main aisle.
- All electrical outlets within 5 feet (1.5 meters) of sinks and serving delicate electrical equipment should be fitted with Ground-Fault Interrupters (GFI). Where thunderstorm activity is a regular meteorological phenomenon, it is essential that outlets be equipped with GFIs. Outlets should be capped when not in use and placed along walls or counters at intervals of 6–8 feet (1.8–2.4 meters).
- Retardant-treated wool fire blankets, free of friable asbestos, should be prominently labeled and strategically placed within 30 steps or 15 seconds of any location in the room.
- A bucket of dry, organics-free sand should be available for alkali metals fires.
- American National Standards Institute (ANSI) coded Z87 or Z87.1 approved safety goggles should be provided for each student when there is danger of chemical or projectile hazard. Specially marked, non-vented goggles should be available for contact lens wearers.
- Sanitizing and/or sterilizing equipment or materials, e.g., ultraviolet cabinets or alcohol swabs, should be available and used between classes to clean safety cover goggles.
- Non-absorbent, chemical-resistant aprons should be provided for each student during laboratory activities where there is a danger of spillage or spattering of chemicals or hot liquids.
- Heavy-gauge metal storage cans with an internal flame arrester (heat sump) should be used for storage and dispensing of flammable chemicals by the teacher only.
- Separate corrosives (primarily for acids) and Occupational Safety and Health Administration/National Fire Protection Association (OSHA/NFPA) approved flammables cabinets (primarily for alcohols and solvents) should be secured in the storeroom.
- A container should be provided and clearly marked for the disposal of broken glass only.
- Containers of diatomaceous earth should be kept available for general chemical spills. Vinegar and sodium hydrogen carbonate (sodium bicarbonate/baking soda) are needed for neutralization of bases and acids respectively. An aspirator and a mercury spill kit should be available for mercury spills. Disinfectants and 10% Clorox bleach solutions should be used to sterilize equipment and wash down counter tops.
- An adequately stocked first-aid kit for teacher use should be easily accessible in an emergency.
- Safety posters should be prominently displayed in the room.
- Emergency procedures and telephone numbers should be prominently posted in the room.

Where should I look for general information on federal safety mandates with which my school system is expected to comply?

The following is a list of federal agencies and their most applicable regulations concerning safety in schools. This list is not to be considered comprehensive. Many of the regulations cited and any recent updates/changes can be found on the Internet at the agency's web address, e.g., www.osha.gov or www.epa.gov.

- Asbestos Hazard Emergency Response Act (AHERA) – Environmental Protection Agency (EPA)
- Code of Federal Regulations (CFR), Appendix C, Part 20, Title 10, United States Nuclear Regulatory Commission (NRC) exempt quantities
- CFR, Part 29 (pertinent sections), Occupational Safety and Health Administration (OSHA) Standards:

  1910. General Workplace Standards

  1910.Subpart Z Exposure Standards

  1910.133 Eyewear Standards

  1910.134 Respirator Standard

  1910.1028 Benzene Standard

  1910.1030 Bloodborne Pathogens Standards

  1910.1048 Formaldehyde Standard

  1910.1200 Hazardous Communication Standard

  1910.1450 Occupational Exposure to Hazardous Chemicals in Laboratories

  1910.20 Access to Employee Exposure and Medical Records
- Resource Conservation and Recovery Act (RCRA) – EPA
- Title III Emergency Planning and Right-to-Know Sections 301-304, 311-313 – EPA
- Title IV – Superfund Amendments and Reauthorization Act (SERA) (indoor air quality) – EPA
- Toxic Substances Control Act (indoor air quality) – EPA

Are there recommended checklists covering the physical layout/specifications of science labs?

Several publications cited in the References contain checklists or information that could easily be used by those wanting to renovate or build new science labs. Much of what is cited below is excerpted from Total Science Safety System software (JaKel, Inc., 1998) with approval of the authors. This is NOT an exhaustive checklist and is only intended to address the secondary (9–12) science laboratory.

- The room should not be overcrowded, with 45–60 square feet (4.2–5.6 square meters) of working space/student, depending upon the type of activities to be performed. It should be designed for no more than 24 students/teacher.
- There should be no less than 6 linear feet (1.8 meters) of workspace per student in the classroom/laboratory.
- In order to meet Americans with Disabilities Act (ADA) requirements for handicapped and disabled students, there should be at least an additional 20 square feet (1.9 square meters) of working space per student.
- Approximately 15 square feet (1.4 square meters) per computer station, 10 square feet (.9 square meters) for a TV with VCR or laser disc player, and 12 square feet (1.1 square meters) for a projector should be added to total lab area to accommodate minimum technological equipment.
- The room should have no blind spots where students cannot be observed and supervised.
- General light level should be between 538.2–1076.4 lumens per square meter with diffuse lighting preferred.
- Aisle width should be adequate (4–5 feet or 1.2–1.5 meters) to accommodate handicapped students and equipment needs.
- The room should have two exits, both opening outward and at least 5 feet wide (1.5 meters) to accommodate handicapped students and facilitate equipment carts and emergency exit. Doors should have reinforced glass viewing windows or peepholes.
- During labs, air in the room should be regularly recycled and mixed with outside air at a rate of 4–12 complete laboratory air changes per hour, depending on the chemicals used.
- The exhaust ventilation system should be separate from that of the chemical fume hood and should meet the American National Standards Institute (ANSI) Z9.5 Standard.
- For high school labs where chemicals of low to moderate toxicity are used, at least one functioning exhaust hood (portable or permanent) that meets American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) 110 testing standard, with a face velocity of approximately 80–120 linear feet/minute (24.4–36.6 meters/minute), should be provided. Exhaust should be vented to the outside through the roof or outside wall. A common through-the-wall hood may serve the laboratory and preparation room. Exhaust hood(s) should be located away (10 feet or 3.1 meters) from entrances/exits, windows, intake ducts, and high traffic areas.
- There should be a telephone or an intercom available for notifying the office and others of emergencies.
- Tile floors should be covered with a nonskid wax.
- There should be lockable storage for certain items. Emergency/master shut-off controls for water, gas, and electricity should be in a securable location near the teacher's station.
- There should be sufficient electrical outlets located at intervals of 6–8 feet (1.8–2.4 meters) that make extension cords unnecessary. They should be capped when not in use. Those outlets within 5 feet (1.5 meters) of water should be equipped with Ground-Fault Interrupters (GFIs).
- Goose-necked faucets should be used on sinks to allow attachment of portable eyewashes and shower hoses.
- Lab surfaces should be made of material unaffected by acids, alkalis, solvents, and temperate heat.

REFERENCES

The following is a list of general references. It should be obvious that it is not exhaustive. The references provided are for those interested in obtaining additional information from primary sources. A much more exhaustive listing of references and resources can be found in two excellent state documents: Guidebook for Science Safety in Illinois, available from the Illinois State Center for Educational Innovation and Reform (contact Illinois State Board of Education) and Maryland Science Safety Manual, K-12, available from the Maryland Science Supervisors Association (contact the Maryland State Department of Education). No implication of endorsement or lack of endorsement should be read into inclusion or omission of any referenced material within this document.

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American Chemical Society: http://www.acs.org

Centers for Disease Control: http://www.cdc.gov

Council of State Science Supervisors: http://csss.enc.org

Eisenhower National Clearinghouse: http://www.enc.org

Environmental Protection Agency: http://www.epa.gov

Flinn Scientific: http://www.flinnsci.com/

Howard Hughes Medical Institute. Online Information Site: http://www.practicingsafescience.org and http://www.hhmi.org/science/labsafe/icss/

Humane Society of the United States: http://www.hsus.org/programs/research/animals_education.html

JaKel, Inc. Online Information Site: http://www.netins.net/showcase/jakel

Kansas City Hazardous Waste Program: http://www.metrokc.gov/hazwaste/rehab/

Laboratory Safety Institute. Online Information Site: http://www.labsafety.org

MSDS Online: http://www.msdsonline.com

National Association of Biology Teachers: http://www.nabt.org

National Fire Protection Association: http://www.nfpa.org

National Institutes of Health: http://www.nih.gov/od/ors/

OSHA Laboratory Standard - 29 CFR 1910.1450: http://www.osha.gov

Sargent-Welch: http://www.sargentwelch.com/html/safetyck.html

University of Virginia: http://keats.admin.virginia.edu/

VWR Scientific: http://www.vwrsp.com/search/index.cgi?tmpl=msds

Wellesley College: http://www.wellesley.edu/ScienceCenter/lab-safe-home.html

Please note: Some of the above-noted Web sites have moved or are no longer available. Please refer to the source, **csss.enc.org/safetym**, for updates as they are issued.

Council of State Science Supervisors
http://csss.enc.org

American Chemical Society
http://www.acs.org

Eisenhower National Clearinghouse
http://www.enc.org

National Aeronautics and Space Administration
http://education.nasa.gov

National Institutes of Health
http://science-education.nih.gov

For additional copies of this publication, contact your state science consultant/supervisor.

Web Sites

All Web sites are current to June 2005, but are subject to change by their host. As a courtesy, please refer to the source if you use information from any of the links provided in this resource.

Biodiesel Information

The following links will provide you with biodiesel information that is downloadable onto a computer and easily printed out for distribution. These files open in Adobe™ Reader, which is available free online at adobe.com.

biodiesel.org/pdf_files/kids_sheet.pdf
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biodiesel.org/pdf_files/CommonlyAsked.pdf
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Enviro-logs

This URL provides the background for a genuinely environment-friendly firelog product.

enviro-log.net/features.htm

Ethanol Resources

ilcorn.org/Education/Ethanol_Fastback/ethanol_fastback.html
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Forest Biomass

psnh.com/Energy/EnergyProject/pdfs/NWPPBrochure.pdf *Web page of a New Hampshire utility that recently made the decision to convert a coal plant to biomass with the ratification behind their decision.*

natural-resources.ncsu.edu/wps/wp/fps/BENNETT.pdf *PowerPoint presentation by Wade Bennett with the Craven Wood Energy project in New Bern, NC.*

nrel.gov/biomass/ *National Renewable Energy Laboratory's site on biomass with information about the latest research.*

fpl.fs.fed.us/documnts/techline/wood_biomass_for_energy.pdf *Overview document on the use of wood biomass for energy, published by the Forest Products Laboratory.*

fpl.fs.fed.us/ *Home page for the Forest Products Laboratory with documents for biomass-related information and publications.*

Web Sites, Cont'd...

serbep.org/ *Regional information about biomass efforts in the Southeast.*
eere.energy.gov/biopower/main.html *US Department of Energy site provides basic information on the benefits of biomass for energy.*
bioproducts-bioenergy.gov/default.asp *Information about the political side of implementing biomass projects.*
ars.usda.gov/bbcc/index.htm *US Department of Agriculture site describes basic information on biomass projects.*
srsfia2.fs.fed.us/ *USDA Forest Service site with up-to-date information on South Carolina's forest resources. Part of the site is interactive — query the database for specific information.*
state.sc.us/forest/fia2000.pdf *The latest report on the status of South Carolina's forest resources.*
state.sc.us/forest/ *Home page for the SC Forestry Commission provides information on various programs.*

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