1.2: SAFETY IS KEY- HOW TO FIND RELEVANT SAFETY INFORMATION AND READ SAFETY DATA SHEETS

Safety is a number one concern for everyone working in a lab. Safety concerns have many different manifestations, and in general, we always work to make everyone as safe as possible by creating a standard procedure for whenever is in the lab. In any given situation in lab (and there are no exceptions), we use the following:

1. **Lab goggles.** Our eyes are very delicate, and almost all chemicals are detrimental for our eye health. Goggles are worn at all times, and they are never removed in the lab. Goggles must be splash proof, which means that they protect the eyes from multiple angles, should chemicals splash.
2. **Lab coat.** The coat is the first line of defense against chemicals that may get in contact with us, and the coat also provides a first line of defense for our clothes.
3. **Fume-hoods.** A fume-hood is a very important part of the lab environment. It is a hood equipped with an adjustable sash, where the air flow inside the hood is very high. This removes any vapors quickly and safely. Everything that you do in an organic chemistry lab, is done in a fume-hood to minimize your exposure to fumes.

In many situations, the use of gloves is also appropriate. This is covered in detail in chapter 3.

The scary reality of working in a lab is that chemicals are dangerous. All substances have some inherent dangers associated with them, and although we spend our times exposed to many chemicals outside of the lab, the lab is a place where we can expose ourselves to a greater variety of hazardous chemicals. As a base line, we will treat any chemical as *dangerous*, and the utmost of care should always be taken to ensure that exposure is at a minimum. Because chemicals do vary in terms of their properties and hazards, it is also necessary to know the exact hazards of each chemical.

Where should you go to look up, identify and familiarize yourself with this information?

The answer is Safety Data Sheets (SDS).

SDS are legally required information sheets that provide an overview of the safety and hazards associated with a given chemical or mixture. There may be thousands of data sheets available for any given chemical, so before I move on, I would recommend using Sigma Aldrich as the main supplier of relevant and reliable data sheets.[2]

The SDS are compiled by the Globally Harmonized System of classification and labeling of chemicals (GHS), an internationally recognized system that standardizes safety and hazard information for chemicals. That means that people from all over the world should be able to access any given SDS and find the same types of information, presented in the same way.

Knowing how to work with SDS is essential for anyone working in a laboratory environment, because they contain information on the risks, hazards and safety issues associated with the chemicals in use. SDS give an informed backdrop to the experiment and helps you make safe and good choices when handling chemicals.

To contextualize this, just imagine that you were planning to handle a chemical that is explosive in contact with water. Knowing this hazard in advance is obviously key to your safety. On the other hand, what if you were planning to handle a carcinogenic substance (a substance that causes cancer)? You would obviously want to know these risks beforehand so that you could work in the safest way possible. Furthermore, if you ever plan to work in a professional laboratory, consulting SDS will be a very important part of your preparation.

---

2 The site http://sigmaaldrich.com/ is usually a good starting point. You can search for chemicals by name or structure.

Let us have a closer look at how a SDS is formatted.

The SDS for any given compound is typically organized into several categories, such as hazards, toxicity, composition, and first aid measures, to name a few.

The information found in a SDS can be misleading if misinterpreted. As an example, let us examine the SDS of sodium chloride (NaCl), which is table salt. Under category 4, which is first-aid information, the SDS states that if the substance is in contact with skin to “Wash off with soap and plenty of water. Consult a physician.” That seems ridiculous. I doubt that any of us call a physician if we get salt on our fingers while we are eating fries, but the restaurant cook who is dipping their fingers into a bowl of salt eight hours a day might wonder if it will cause any harmful effects. The SDS also lists information about the “acute toxicity” of sodium chloride. The data stated is LD50 Oral Rat 3,550 mg/kg. How does one interpret this?

LD_{50} Oral Rat refers to the amount of salt that will kill 50% of the rats who swallow it. Because rats come in all sizes, the amount is expressed as ratio between mass of compound and mass of rate. In this case, 3550 mg (or 3.55 g) of sodium chloride will kill 50% of rats who weigh 1kg.

If we assume that human bodies work like rats, we can find a lethal dose for half a population of humans. If we assume that a human weigh 100 lb (which is a convenient number) or 45.4 kg, then 45.4 x 3.55 = 161 g NaCl might be lethal to 50% of the humans who swallow it. 161 g is over 1/3 lb of salt, so the fries would probably kill you before the salt did, but there is how you interpret this figure.

As you can see from this example, the reliable information in the SDS has to be worked out ina realistic context. In this particular case, we have learned that sodium chloride can be lethal if ingested in (relatively) large amounts.

Here are some of the hazards categories that SDS frequently identify for organic chemicals, and some notes about each category to help you get started. Please note that this list is not exhaustive.

Table 1. Some common safety categories

Category	Type	What does it mean?	Additional comments.
Flammable	Physical	A liquid, gas, solid or solution is flammable. Usually a spark or	Most organic liquids are flammable, so the risk of starting a fire is always present and necessary steps must always be taken to avoid such risks.
Oxidizing	Physical	The compound is a strong oxidant.	If you mix an oxidant with a reductant, usually a strongly exothermic reaction happens. Care should be taken to avoid this. Some oxidizers must also be disposed of in a particular way.
Pyrophoric	Physical	The compound ignites spontaneously in contact with air.	Pyrophoric substances are very dangerous, and usually require handling in inert gas.
Toxicity	Health	A substance is toxic.This category is vast, and requires specific	Most organic molecules are toxic by numerous modes. We have dedicated a separate section to toxicity below this table.
Skin irritation	Health	A substance irritates the skin and/ or mucus membranes	Most organic chemicals irritate the skin. If the compounds are solids, gloves often offer sufficient protection, assuming the substances do not permeate
Eye irritation /damage	Health	A substance irritates or permanently damages the eye	Because the eye is so delicate, most chemicals and substances damage the eye. One of the most basic safety feature of any lab, is that the people working

Carcinogen	Health	A substance that is suspected or known to cause cancer in mammalian cells.	This is a very important category, as substances that are either suspected or known carcinogens must be handled with extreme care. It is important to note the two subcategories of suspected and known. In practical lab work, you should deal with both these chemicals the same way: very carefully
Reproductive toxicity	Health	The substance damages the reproductive system	This is a very important category, as chemicals that damages the reproductive system can have very detrimental effects.

How do you use the SDS information in your preparation phase?

1. **Read all SDS for all chemicals encountered in the experiment.** Pay particular attention to category 2, which contains a summary of the hazard statements for the chemical.
2. **Analyze the information in the SDS.** Think carefully about what measures can (and should!) be taken to avoid exposure, and to minimize the potential risks associated with the chemical.
3. **Write it down.** Include the major hazard statements for each chemical in your notebook. Also, include any important analysis you have done.
