Chemical Management and Selection of Disinfectants

2020

Objectives

At the end of this session participants will understand,

- Chemical Hazard Recognition
- Chemical characteristic found in MSDS/SDS
- Chemical Hazard evaluation
- Chemical Hygiene plan
- Selection of Disinfectants
- Factors to consider before selection of disinfectants

Employee Training

- Within **1st week** of initial employment or assignment to a new job
- Whenever new hazards or chemicals are introduced to the workplace
- In case of an incident / exposure / accident
- Annually

Employee Must be Informed

- Physical & chemical characteristics
- The Right to know law
- Chemicals in the work place
- Location and availability of MSDS
- Location of spill kits, eye wash stations and
- Choice of disinfectants

Why Learn about Chemical Hazards?

- Most common & significant health hazards
- Chemicals can be hazardous for numerous reasons & can combine with other chemical = new hazards
- All hazards must be taken in to account when using and storing chemicals

Areas to Cover

- Recognize chemical hazards commonly encountered in labs
- Provide examples of physical and health Hazards
- How to use and understand a Safety Data Sheet / safety data base
- Explain warning properties of various chemical hazards, how to control and evaluate them.

Areas to Cover…

- Chemical hygiene plan
- Chemical disposal
- Spill kits and how to select disinfectants

Chemical Hazard Recognition

Degree of hazard associated with a specific chemical will depend on:

- Its physical & chemical properties
- Its toxicity
- The way it is used in the lab
- The environment in which it is encountered

Physical Classification

Chemicals may be found in different forms and the danger is determined by its form:

- **Solids** - Lead pipe & Nickel (sanded & welded = dust / fumes; contact = dermatitis); pesticides evaporate direct from solids; avoid contact with acids & bases.

Physical Classification …

- **Liquids** - contact with skin- absorption or inhaled. Degree of hazard depends on its concentration and handling. e.g. Inhalation is the 1^0 entry route into the body.
- Vapour pressure is vital to determine the hazard. Low vapour pressure = low airborne concentration= low toxicity

Physical Classification …

- Some chemicals help other contaminants to penetrate the skin. e.g. Dimethyl sulfoxide is extremely well absorbed in the skin and is used in medicine to transport drugs in the body.
- Liquids present a splash hazard; (goggles, faceshields, gloves coveralls) to prevent eye and / or skin contact.
- Some liquids combine with others = new hazards: house hold bleach and ammonia

Physical Classification …

- **Gases and vapors:**
  - At gaseous state molecules are unrestricted by cohesive forces.
  - Vapors are evaporation products of chemicals that are normally liquids at room T^0

Physical Classification …

Aerosols

- Invisible/ visible fine solid or liquid particulate matter in the air (dust, fumes , mist, fog, smoke).
- Knowledge on how various aerosol are produced assists you anticipate where aerosol hazards may exist.
- Hazardous when in contact with: eye, skin, respiratory system and ingestion system.
- Know all routes of chemical exposure as per specific hazard

Spills

- Classified into three classes: minimal aerosols, large aerosols, and radioactive spills.

Chemical Characteristics

- Understanding chemical characteristics you anticipate using in lab helps you to identify the hazards & protect yourself.
- This is obtained from MSDS / MSDB of a specific chemical.
- MSDS must be available in the work place and easily accessible to every employee.
- All must understand how to use it.

Chemical Characteristics …Information found on SDS

1. Chemical Product and Company Identification
2. Composition and Information on Ingredients
3. Hazards Identification
4. First Aid Measures
5. Fire and Explosion Data
6. Accidental Release Measures
7. Handling and Storage
8. Exposure Control/Personal Protection
9. Physical and Chemical Properties
10. Stability and Reactivity Data
11. Toxicological Information
12. Ecological Information
13. Disposal Considerations
14. Transport Information
15. Other Regulatory Information
16. Other Information

Chemical Characteristics …..

- **Chemical Flashpoint:**
  - The lowest T^o at which a liquid gives off enough vapor to form an ignitable and produce a flame in the presence of a heat source.
  - Ignition continues as long as the T^0 is above the flash point!
  - Some liquids have a low and others have a high flash point.

Chemical Characteristics …

- **Vapor pressure:**
  - Is the pressure exerted on the sides of the container, and is proportional to T^0 (mm Hg).
  - The higher the vapor pressure the more volatile the liquid.
- **Explosive limits:**
  - Range of concentration of gases in air to support explosive process. Its measured by **UEL/LEL**

Warning Properties

You can be alerted to the presence of a chemical in the air by :-

- **Odor threshold** (airborne concentration)
- This must be used with caution due to the ranges in individuals sense of smell.
- Sense of smell can be negatively affected by: allergies, head colds, olfactory fatigue, and diminished function.

Warning Properties …

- **Color product:** vapour / gas (nitric acid = red, chlorine =blue)
- **Other sensory signal:** mild irritation of eyes, nose, throat, skin.
- Some chemicals will produce a taste before or instead of the odor or irritations.

Chemical Hazard Evaluation

- Identify materials present & obtain knowledge on their hazardous status
- Ensure employees are aware of them and have access to the hazard information - MSDS
- Take precautions if when you are unsure if a hazard exists
- Check for the presence of corrosive properties

Chemical Grouping

MAJOR GROUPS (categories)
Segregation and position
Some chemicals have multiple hazards and therefore require further segregation

- **Flammables**
- **Oxidizers**
- **Corrosives : *Acid, Neutral, Base (PH)***
- **Inorganic or Organic (CH_20H, Ca, Cd, $H_2SO_{4)}$**

Solid or Liquid; Store separately to avoid accidents in case of chemical/liquid spill

Chemical Hygiene Plan

- To out line procedures to protect employees from health hazards associated with chemicals
- Follow OSHA / CDC/NIH guidelines
- Controlled by SHE manager (safety officer) / MSDS
- Include occupational health surveillance
- Copies of job hazard analysis
- Annual CHP inspection
- Chemical Inventory **
- Proper & adequate PPE

Chemical Disposal

- Consider the hazard associated with use of the chemical.
- STATE the general safety precautions necessary for the handling, storage, and disposal of corrosives/Oxidizers/Flammables.

Chemical Disposal…

- Two basic groups of corrosives: **acids** and **alkalis**.
- Acids are corrosive in any form, and in high concentrations destroy body tissue and cause severe burns on contact with the skin and eyes.
- Some acids are strong oxidizing agents and react destructively and violently with organic and other oxidizing agents.

Chemical Disposal…

Handling and disposal of corrosive chemicals should be done in accordance with lab protocol established by the principal investigator.

Recommended way is Neutralization

- **$HCL_{(l)} + NAOH_{(l)} = NACL_{(aq)} + H_2O_l$ down the drain (minimal volumes)**

  ($NAHCO_3$)

- **NAOH + ADD WATER SLOWLY**

- **CH_2OH BURN $CO_2 + H_2O$**

Chemical Disposal…

- **HNO_3 Neutralize with 5% NAOH or NA_2CO_3**
- **H_2SO_4 dilute NAOH = $NASO4_{aq}$ + $H2O_l$ OR Baking soda (messy form)**
- Do not use Drain cleaners as a source of caustic soda (mixture of sodium hydroxide and aluminum flakes, generates explosive H_2
- Cleanup and decontamination may require the use of neutralizing agents.

Flammable or Explosive Substances

- Flammables (flash point less than 100F) or explosive at the time of disposal - must not be disposed into a sink or drain as they will create unfavorable conditions during low flow

Oxidizers

- All oxidizing chemicals and agents should be disposed in the thermal oxidizer evaporator.
- The **thermo oxidizer evaporator** is *designed to completely evaporate liquid waste, leaving only a non hazardous dry ash residue.*
- The evaporator Atomizes the liquid waste stream into a fine non hazardous mist.

Oxidizers …

- **Flash evaporation** reduces the entire water and organic volume in a waste stream leaving only a non hazardous dry residue to be removed.

Labeling and Marking Systems

There are three labeling and marking systems used to quickly identify hazards:

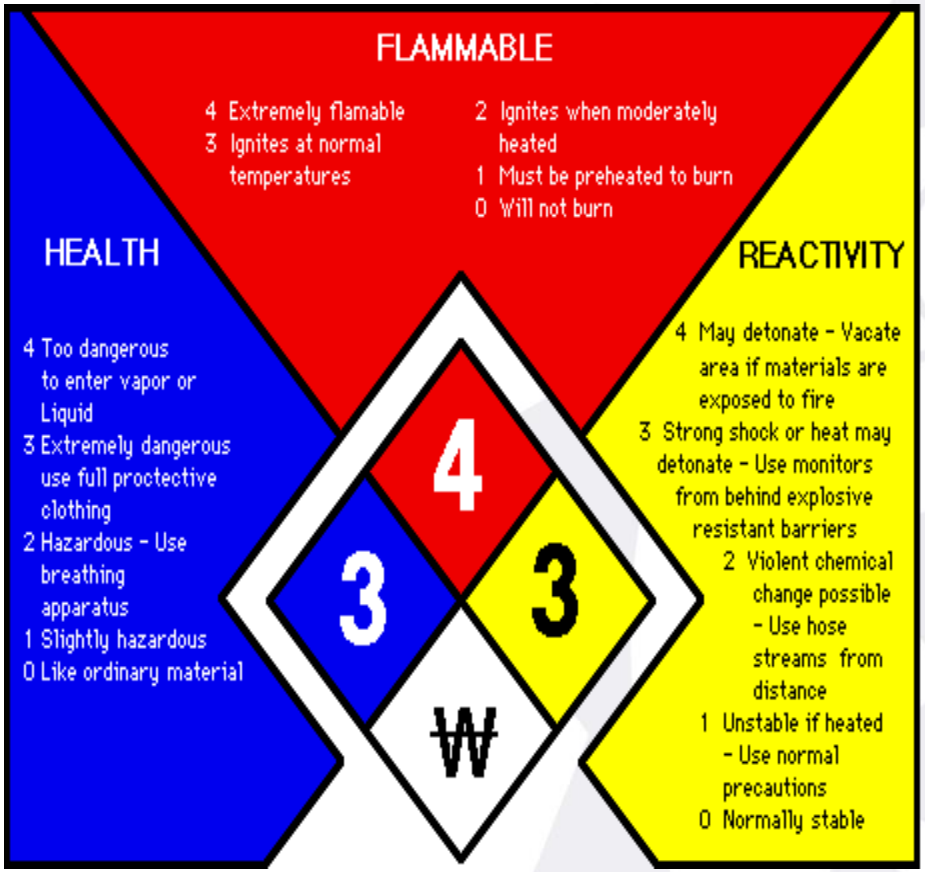
1. **National Fire Protection Association (NFPA)**
2. **Hazardous Materials Information System (HMIS)**
3. **Uniform Laboratory Hazard Signage (ULHS)**

The first two systems rely on color codes and a numerical rating system to identify the hazard and its severity.

National Fire Protection Association (NFPA)

The diamond identification system:

- Uses four colors and a 0-4 numeral rating for hazards
- **Blue Health**
- **Red Flammability**
- **Yellow Reactivity**
- **White Special information**
- Numerical rating begins at 0 and goes thorough to 4
- **0** least severity and **4** most severity in hazard

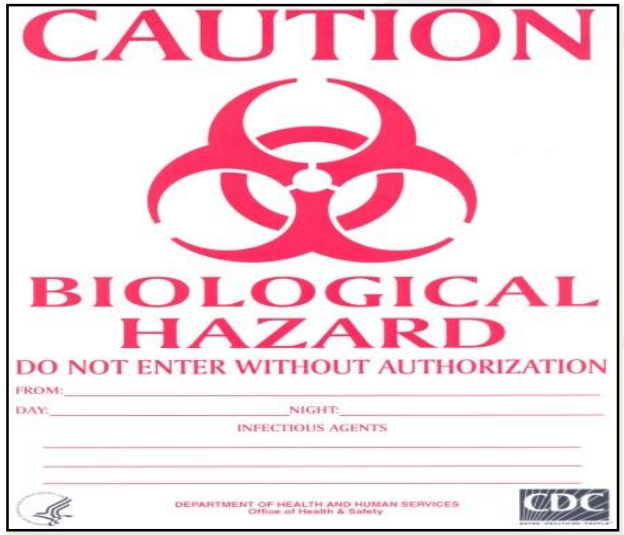


Hazardous Materials Information System (HMIS)

- Rating of **0** in this system indicates the least severity**: will not burn, stable, no hazard**
- Rating of **4** in this system indicates the most severity: **deadly.**

Uniform Laboratory Hazard Signage (ULHS).

- The pictograph identification system
- These **symbols used to help identify hazards**

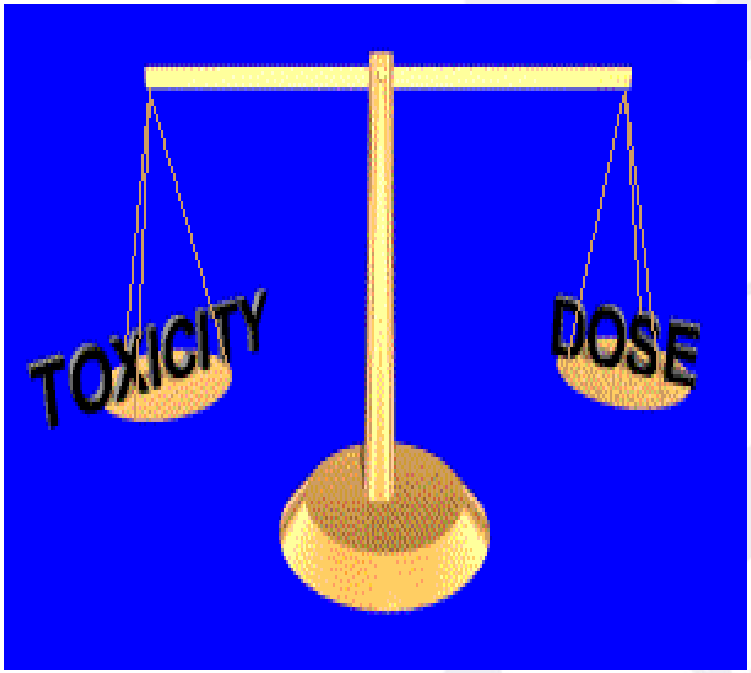


Chemical Inventory List

- Be on line
- Monthly inventory conducted

Toxicity vs. Dose

- There is a balance between toxicity and dose.
- Dose is the AMOUNT of something you are exposed to, or come in contact with.
- The less the toxicity, the greater the dose you can tolerate without ill effects.
- The greater the toxicity, the less dose you can tolerate without becoming sick



High Toxicity - Low Dose

- For example, acetone is a highly toxic chemical. But you could work safely with it,
- if you were outside or in a well ventilated room where your dose would be very low. As the chart below shows, your hazard potential for working with acetone in a well ventilated room would be low.

TOXICITY	Very Low	Low	Moderate	High	Very High
HAZARD POTENTIAL	**Very Low**	**Low**	**Moderate**	**High**	**Very High**
DOSE	Very Low	Low	Moderate	High	Very High

Low Toxicity - High Dose

- Let's take another example. Nitrogen gas has a low toxic rating. It is found in great amounts in the air we breathe.
- However, if you were in a confined space that had only nitrogen gas in it (a very high dose), you would soon die because of the lack of oxygen.
- As the chart below indicates, your hazard potential for working in a room filled with nitrogen would be high.

TOXICITY	Very Low	Low	Moderate	High	Very High
HAZARD POTENTIAL	**Very Low**	**Low**	**Moderate**	**High**	**Very High**
DOSE	Very Low	Low	Moderate	High	Very High

Before Lab Work, Get to Know:

- Hazards of materials & agents and their prescribed safety procedures especially chemicals

Get to Know …

- Emergency spill procedures, use of absorbents and disinfectants
- Designated escape route and alternate
- Location of fire ext., eye wash, shower, first aid, and spill kits

Chemical Spill Emergency Response Plan (ERP)

- Identify the spill - determine extent of spill
- Prioritize personal safety - stop breathing and evacuate laboratory area
- Secure the entry into room to insure others do not enter
- Categorize incident as minor or major spill - if minimal, reenter area masked, gloved, and gowned and cover the spill with absorbent towels soaked with disinfectant.

Chemical Spill Emergency Response Plan (ERP) …

- Leave room for minimum of two hours. If large, evaluate entire area. Turn off air conditioner or air handler to the affected area.
- Notify supervisor and prepare accident report.

Chemical Spill Emergency Response Plan (ERP) …

- Read MSDS
- Know location of eye wash station or shower
- Ventilate room in case of fumes
- Report injuries to health services
- Use first aid kit

General Hazard Control Practices

- Avoid direct contact with the chemical
- Limit exposure levels and time
- Enforce good hygiene practice, PPE
- Take appropriate fire prevention & control measures
- Use equipment not affected by metal being handled
- Ensure the chemical is not mixed with others
- Use engineering & good common sense
- Ensure you have proper disinfectants.

Selection of Disinfectants

- **Definition:** Disinfectants are chemicals used to kill micro-organisms on infected instruments.
- Disinfectants are **not** meant to be used on the skin or mucous membranes (used on inanimate objects).

General Guidelines for Use of Disinfectants

Disinfectants are generally toxic and may damage or irritate the skin, conjunctiva and mucosa.	• Care must be taken to avoid contact with irritant or toxic concentrations and disposable gloves should be worn when handling them.
Choose a disinfectant that is suitable for the purpose required.	• Each laboratory should have a written policy specifying the kind and concentration of disinfectant for each type of use.

General Guidelines …

Use disinfectants at the correct concentration.	• Too little is ineffective and too much may be an irritant to the skin.
Working solutions of disinfectants should be renewed per the manufacturer's recommendation.	• Solutions deteriorate during use due to their inactivation by the microbes and other organic materials to which they are applied.

General Guidelines …

Disinfectant solutions must not be overloaded with bacteria or organic materials such as culture media:

- Large number of susceptible bacteria is not killed, excessive organic material inactivates disinfectants.

Disinfectants take time to act.

- Time for effective disinfection will vary with:
  - Microbial load
  - Temperature
  - pH
  - Nature of exposed surfaces
  - Presence of resistant bacteria or spores

General Guidelines …

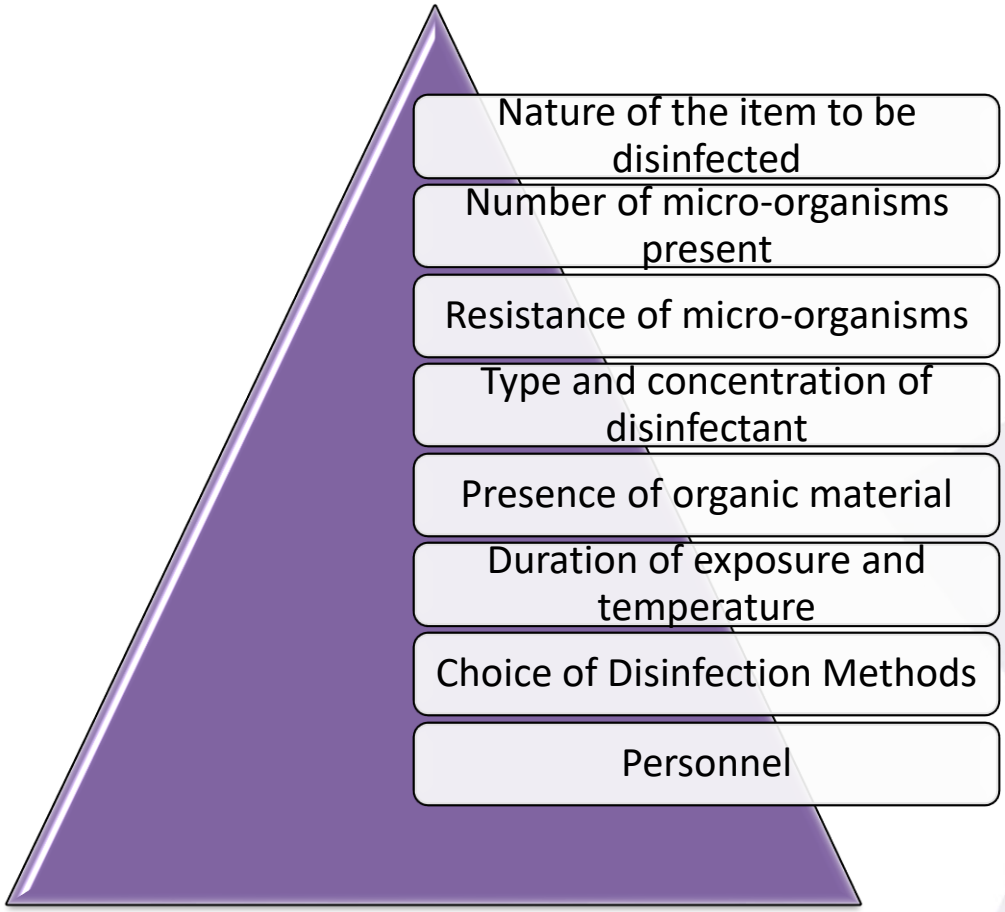
Overnight exposure at room temperature is considered to be adequate for most purposes.

- As long as no fresh batch of contaminated materials are added

Certain disinfectants are easily inactivated by changes in pH, the presence of soap or detergents of opposite polarity or by the presence of cotton, cellulose, cork, rubber and other discard materials.

- Disinfectants should not be mixed with other disinfectants, cleaning solutions or chemicals.

Factors to Consider before Choosing Disinfectants



Factors …

Nature of the item to be disinfected

- The rougher the surface, the longer the contact time required for disinfection (crevices, hinges, lumen).

Number of micro-organisms present

- Number of micro-organisms present will lengthen the time for effective disinfection to take place. Higher bio-burden requires more time for disinfection.

Factors …

Type and concentration of disinfectant

- Resistance of micro-organisms depends on the type of disinfectant used. A particular micro-organism may be more resistant to one type of disinfectant than another. E.g. Alcohol (isopropyl or ethyl) is effective against vegetative bacteria and most lipophilic viruses, but is not effective against bacterial spores or most hydrophilic viruses.
- Many disinfectants are broad spectrum; that is, effective against all or most forms of microbial life.

Factors …

Presence of organic material

- Presence of organic soiling matter will compromise disinfection.
- Blood, blood products, body fluids, and feces contain significant amounts of proteins, and protein will bind and inactivate some disinfectants or slow their action.
- Require high concentrations for organic matter.

Factors…

Duration of exposure and temperature

- Longer the duration of exposure - higher degree of disinfection achieved.
- Longer contact time - killing, and some microorganisms need longer exposures to be killed.
- Higher temperatures increase the killing power of most disinfectants, whereas lower temperatures may slow the killing power of most disinfectants.

Factors …

Choice of Disinfection Methods

- When compatible with other requirements, disinfectants used should be bactericidal rather than bacteristatic; active against a wide range of micro-organisms and should not be readily inactivated.

Factors …

Personnel

- The disinfectants are diluted by knowledgeable personnel in manageable quantities

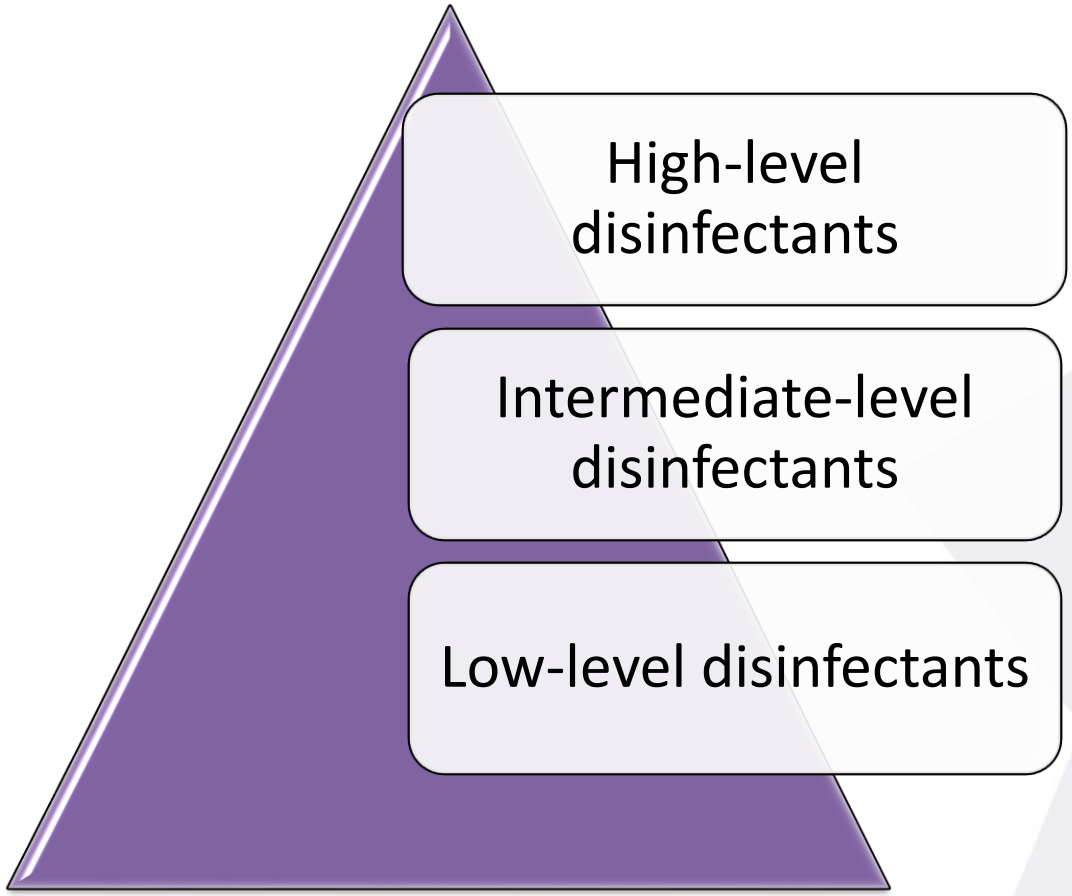
Factors …

Resistance of micro-organisms

Some micro-organisms are more resistant to disinfection than others. The generally accepted order from the most resistant to the least resistant is: bacterial spores, Mycobacterium, hydrophilic viruses, fungi, vegetative bacteria, lipid viruses.

Example: Disinfecting a spill with a small concentration of bacterial spores will require longer disinfection time than a large concentration of lipid viruses.

Types of Disinfectants



High-level Disinfectants

- Glutaraldehydes, formaldehyde, peracetic acid
- Kill bacteria, viruses, fungi, Mycobacterium tuberculosis and some, but not necessarily all bacterial endospores.

Intermediate-level Disinfectants

- Alcohols and chlorines
- Kill mycobacteria, most viruses, and bacteria.
- Recommended for use on blood and other potentially infectious materials.
- Small, non-lipid viruses, (e.g. enteroviruses) may be resistant.
- Used for some non-critical items, or devices, or environmental surfaces.

Low-level Disinfectants

- Phenolics and 3% H_2O_2
- Kill some bacteria and some viruses and fungi, but do not kill TB germs, micro-organisms and bacterial endospores.
- Used for cleaning surfaces, such as floors and counter tops.

Examples of Disinfectants

- Alcohols:- 60%- 70% Isopropanol (have relatively poor efficiency and susceptible to interference)

- Aldehydes: Formaldehyde and Glutaraldehyde (Don’t use for general disinfection; fumigation)

- Hypochlorite: (Bleach & chloros)

Dilutions of Household Bleach

Volume of Bleach	Volume of Water	Dilution Ratio	Sodium Hypochlorite (%)	Available Chlorine (PPM)
Undiluted	0	1:1	5.25	52, 500
1	9	1:10	0.5	5,000
1	99	1:100	0.05	500

Employee Exposure Report Forms (EERF)

- Accident report form used for reporting of chemical exposure, blood borne pathogen or infectious exposure
- For documentation of a work-related exposure.
- To ensure proper medical care is received due to a work-related illness
- Documentation provides proof and protection.

Key Messages

Methods to reduce risks associated with chemicals hazards :-

- Recognize chemical hazards based on their physical properties, toxicity, use and environmental conditions present.
- Familiarize yourself with chemical and physical characteristics as well as the warning properties of chemical hazards .

Key Messages

- Be aware of effects environmental factors may have on a potential hazard
- Know hazard control and evaluation methods for potential hazards
- Always consult MSDSs or other ref. sources
- Familiarize yourself with hazard classes
- Know how to select disinfectants.

THANK YOU