

# Lecture 5: Toxicology & Chemicals at Work

**Course:** Health Safety & Environment

**Instructor:** Kashif Liaqat

**Term:** Fall 2021

BUITEMS – DEPARTMENT OF MECHANICAL  
ENGINEERING

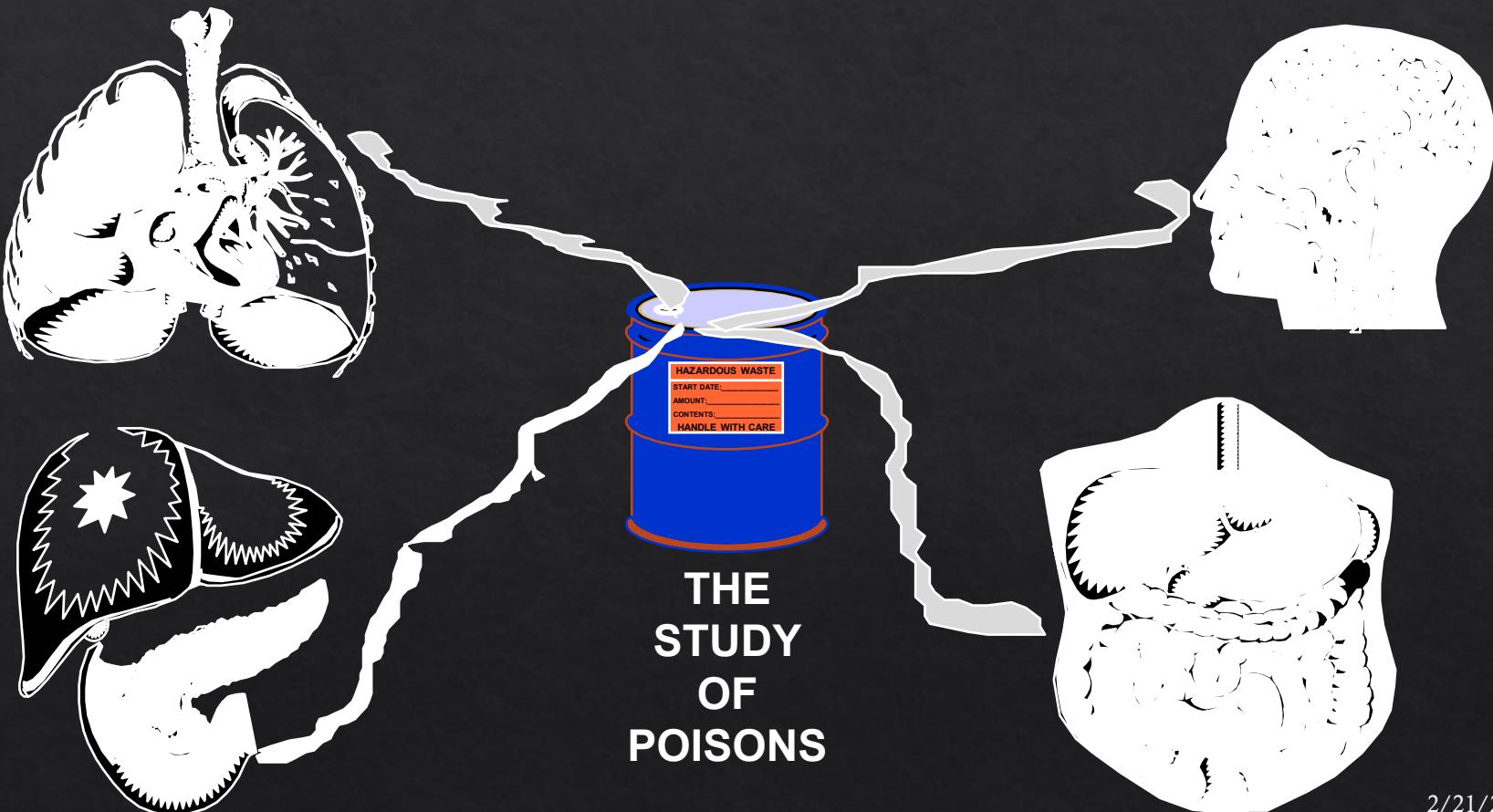


# Toxicology

- ❖ Definition

"the study of the adverse effects of chemicals or physical agents on living organisms "

# INTRODUCTION TO TOXICOLOGY



# GENERAL CONCEPTS OF TOXICOLOGY

## EXPOSURE TERMINOLOGY

**Hazardous Material.** A Material That Falls Into One or More Of the Following Categories. Hazardous Materials Can Have One or Many Characteristics That Can Add to the Intensity of the Toxic Action of a Particular Solid, Liquid, or Gas.

- Ignitability** Is Flammable or Combustible.
- Reactivity** Can React With Itself or Other Materials.
- Corrosivity** Can Deteriorate Another Substance.
- Toxicity** In Its Normal State Is Harmful to Living Things.

# GENERAL CONCEPTS OF TOXICOLOGY

**EVERYTHING IS TOXIC;**  
**IT ALL DEPENDS ON THE DOSE**

*How Well the Body Accepts a Substance Depends on:*

- The Type of Substance.**
- The Amount (Dose) Absorbed.**
- The Period of Time Over Which It Is Absorbed.**
- The Susceptibility/Sensitivity of the Person Exposed.**

# GENERAL CONCEPTS OF TOXICOLOGY

(Continued)

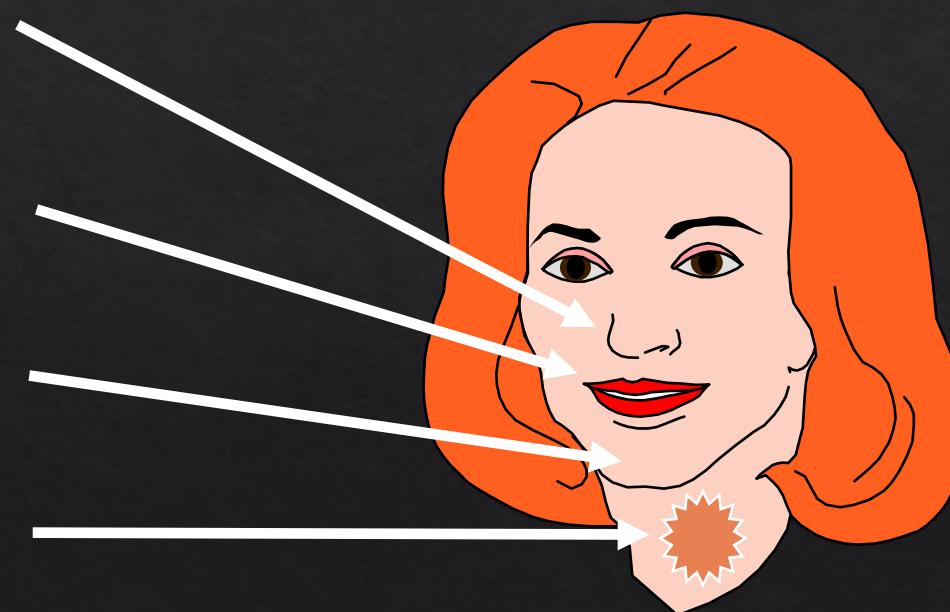
## FOUR PRIMARY ROUTES

INHALATION

INGESTION

ABSORPTION

INJECTION

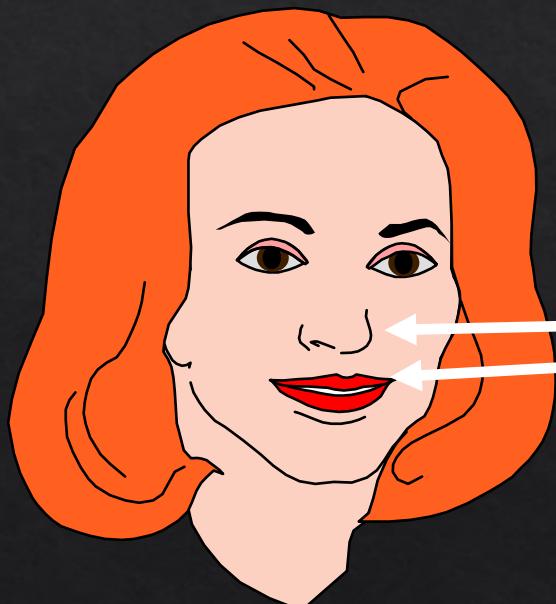


# GENERAL CONCEPTS OF TOXICOLOGY

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## INHALATION

Breathing and smoking causes us to inhale substances which enter the lungs. Substance inhaled into the lungs are readily absorbed into the blood stream.



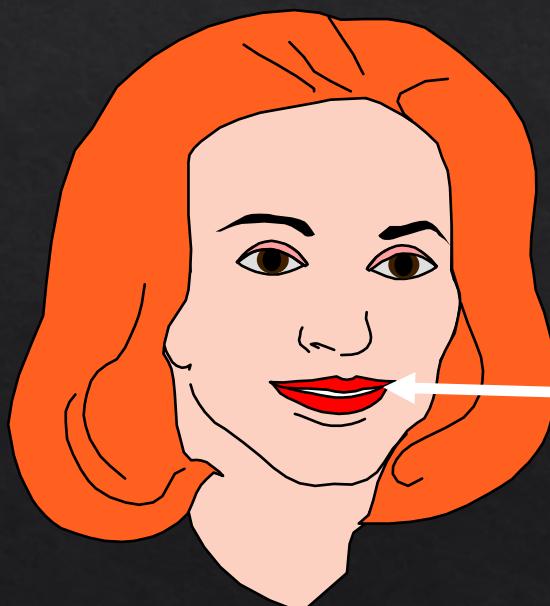
- INHALATION**
- INGESTION**
- ABSORPTION**
- INJECTION**

# GENERAL CONCEPTS OF TOXICOLOGY

(Continued)

## INGESTION

Swallowing a substance causes penetration into the blood stream via the stomach and small intestine.



- INHALATION
- INGESTION
- ABSORPTION
- INJECTION

# GENERAL CONCEPTS OF TOXICOLOGY

(Continued)

## ABSORPTION



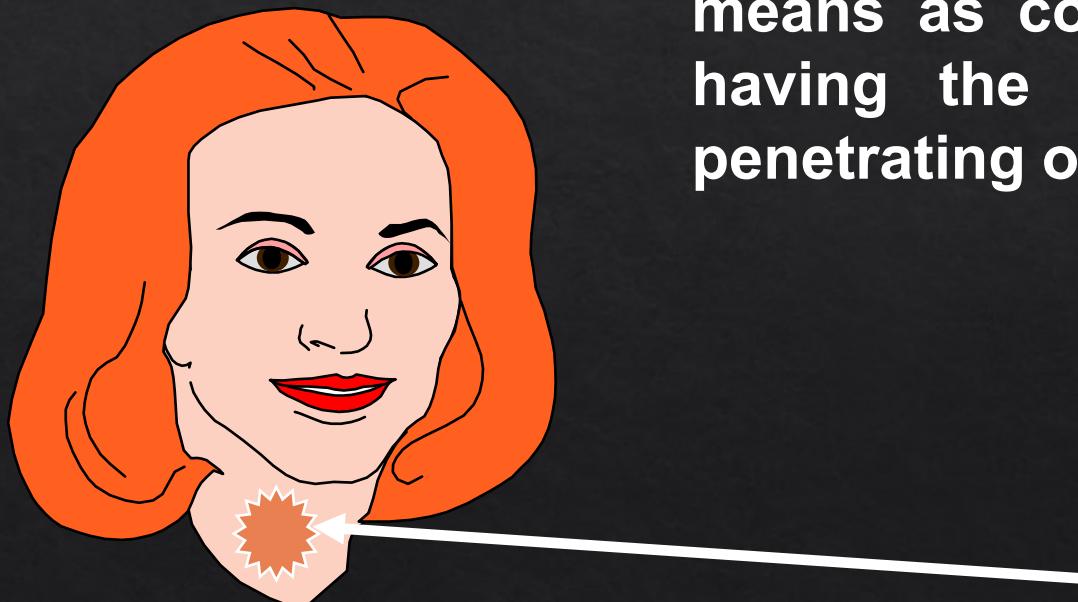
Entering the body through the skin causes substances to enter the blood stream at a slower rate than by inhalation or absorption. However, the resulting entry and distribution within the body is the same.

- INHALATION
- INGESTION
- ABSORPTION
- INJECTION

# GENERAL CONCEPTS OF TOXICOLOGY

(Continued)

## INJECTION



Injection occurs when substances are forced through this skin. This can occur as a result of such means as compressed air, or by having the skin abraded by a penetrating object.

- INHALATION
- INGESTION
- ABSORPTION
- INJECTION**

# FACTORS INFLUENCING TOXIC ACTION

- RATE OF ENTRY
- ROUTE OF EXPOSURE
- AGE OF INDIVIDUAL
- STATE OF HEALTH
- PREVIOUS EXPOSURE LEVELS
- WORKPLACE ENVIRONMENTAL FACTORS
- INDIVIDUAL SUSCEPTIBILITY AND HEREDITY



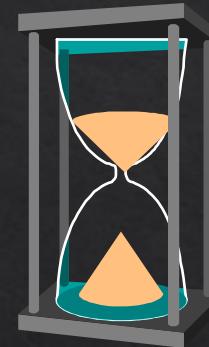
# EXPOSURE TERMINOLOGY

- Acute Exposure:**

Usually Minutes, Hours or Several Days.

- Chronic Exposure:**

Regular Exposure Over Months, Years, or a Lifetime.

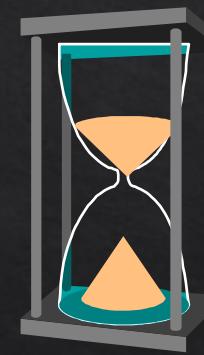


The Toxicity of the Chemical or Material Combined With the Susceptibility of the Individual Determines Whether the Exposure Is Acute or Chronic.

# EXPOSURE TERMINOLOGY

(Continued)

- Latent Exposure:** An injury or disease that remains undeveloped until an incubation period has elapsed. The period of time could be hours, days, months or years.



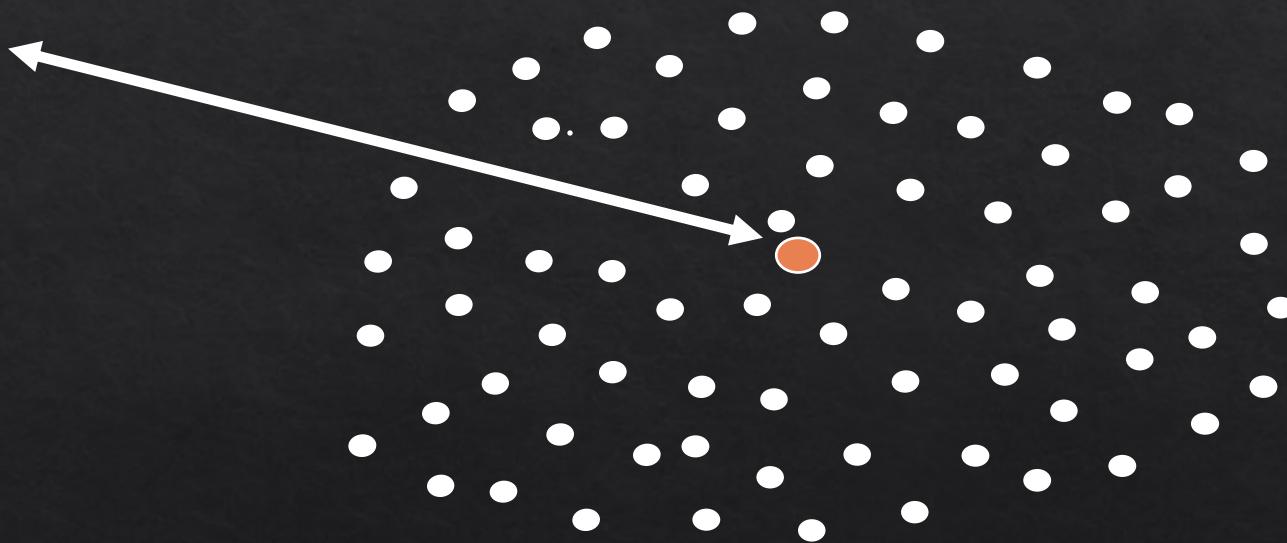
The Toxicity of the Chemical or Material Combined With the Susceptibility of the Individual Is a Key Factor.

# MEASUREMENT OF TOXICITY

(Continued)



**PARTS PER MILLION - ppm**



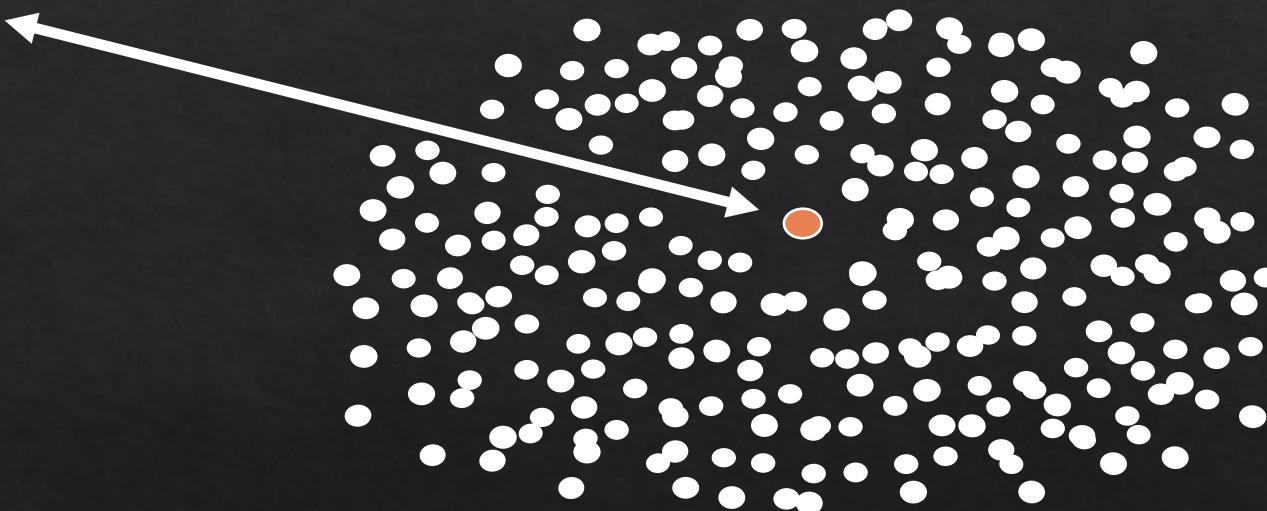
**ONE PART IN ONE MILLION PARTS**

# MEASUREMENT OF TOXICITY

(Continued)



**PARTS PER BILLION - ppb**



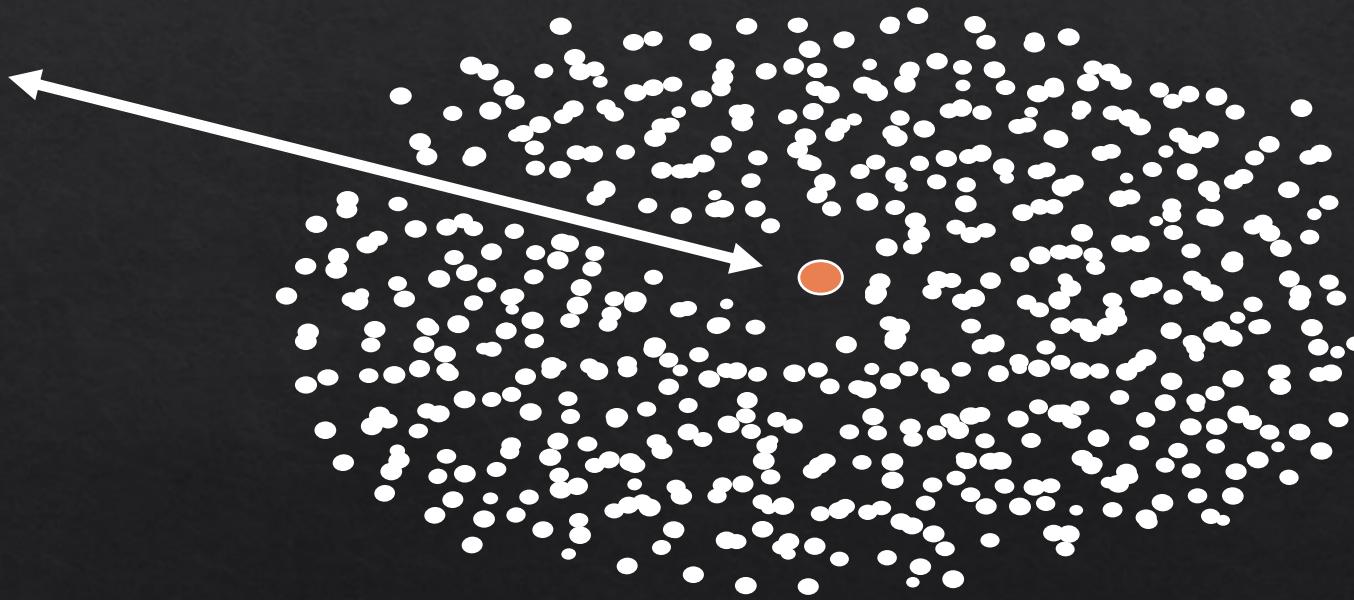
**ONE PART IN ONE BILLION PARTS**

# MEASUREMENT OF TOXICITY

(Continued)



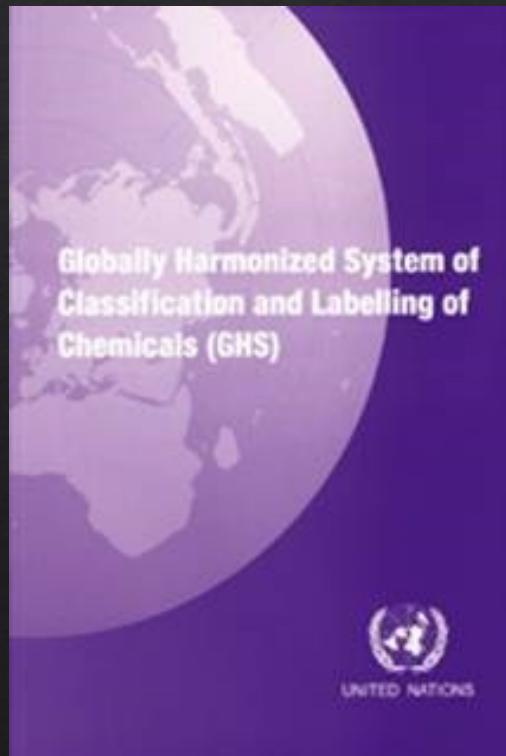
## PARTS PER TRILLION - ppt



ONE PART IN ONE TRILLION PARTS

# GHS

❖ Globally Harmonized System of Classification & Labeling of Chemicals



# GHS

- ❖ A system for standardizing and harmonizing the classification and labeling of chemicals
- ❖ Defines health, physical and environmental hazards of chemicals
- ❖ Communicates hazard information, as well as protective measures, on labels and Safety Data Sheets (SDS).

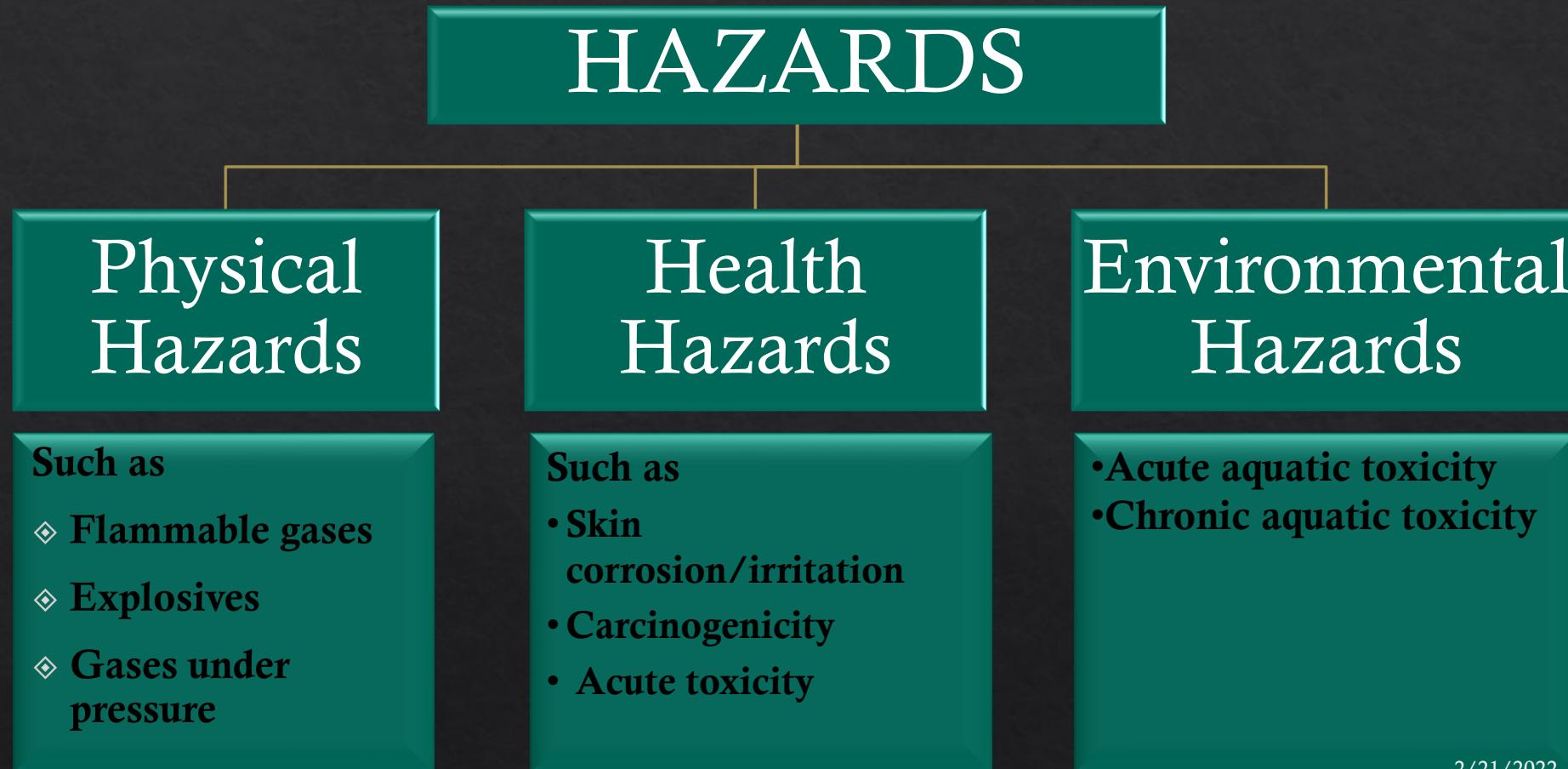
# Why Was GHS Developed?

- ❖ To provide sound management of chemicals that includes a system through which chemical hazards are identified and communicated to all who are potentially exposed

# International Mandate

- ❖ Adopted in the 1992 United Nations Conference on Environment and Development (UNCED), often called the "Earth Summit".
- ❖ It was recognized that an internationally harmonized approach to classification and labeling would provide the foundation for all countries to develop comprehensive national programs to ensure the safe use of chemicals.

# HAZARD CLASSIFICATION



# Hazard Classes

- ❖ 16 classes of physical hazards
- ❖ 10 classes of health hazards
- ❖ 3 classes of environmental hazards

# GHS Physical Hazards

- ◊ Explosives
- ◊ Flammable Gases
- ◊ Flammable Aerosols
- ◊ Oxidizing Gases
- ◊ Gases Under Pressure
- ◊ Flammable Liquids
- ◊ Flammable Solids
- ◊ Self-Reactive Substances
- ◊ Pyrophoric Liquids
- ◊ Pyrophoric Solids
- ◊ Self-Heating Substances
- ◊ Substances which, in contact with water emit flammable gases
- ◊ Oxidizing Liquids
- ◊ Oxidizing Solids
- ◊ Organic Peroxides
- ◊ Corrosive to Metals



# GHS Health Hazards

- ❖ Acute Toxicity
- ❖ Skin Corrosion/Irritation
- ❖ Serious Eye Damage/Eye Irritation
- ❖ Respiratory or Skin Sensitization
- ❖ Germ Cell Mutagenicity
- ❖ Carcinogenicity
- ❖ Reproductive Toxicology
- ❖ Target Organ Systemic Toxicity - Single Exposure
- ❖ Target Organ Systemic Toxicity - Repeated Exposure
- ❖ Aspiration Toxicity

# GHS Environmental Hazards

- ❖ Hazardous to the Aquatic Environment
- ❖ Acute aquatic toxicity
- ❖ Chronic aquatic toxicity
  - ❖ Bioaccumulation potential
  - ❖ Rapid degradability



# GHS Label Elements

- ❖ Product Identifier
- ❖ Signal Word (Danger, Warning)
- ❖ Hazard Statement (for each hazard class and category)
- ❖ Pictogram(s)
- ❖ Precautionary Statement (for each hazard class and category)
- ❖ Name, Address and Tele. # of chemical manufacturer

# Hazard Statement Examples

- ◊ “Causes eye irritation”
- ◊ “Toxic if inhaled”
- ◊ “Flammable aerosol”
- ◊ “May cause cancer”
- ◊ “May cause respiratory irritation”
- ◊ “Harmful to aquatic life”
- ◊ “Contains gas under pressure; may explode if heated”

# Health Hazard



Carcinogen  
Mutagenicity  
Reproductive Toxicity  
Respiratory Sensitizer  
Target Organ Toxicity  
Aspiration Toxicity

# Environment



Aquatic toxicity

# Exclamation Mark



Irritant (skin and eye)  
Skin Sensitizer  
Acute Toxicity  
Narcotic Effects  
Respiratory Tract Irritant  
Hazardous to Ozone  
Layer (Non-Mandatory)

# Skull & Crossbones



Acute toxicity  
(fatal or toxic)

# Gas Cylinder



Gases Under  
Pressure

# Corrosion



Skin Corrosion/Burns  
Eye Damage  
Corrosive to Metals

# Exploding Bomb



Explosives  
Self-Reactives  
Organic Peroxides

# Flame Over Circle



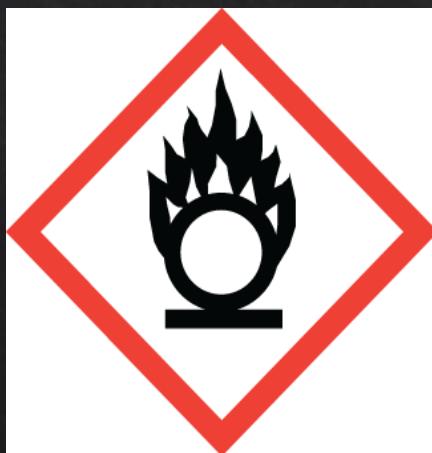
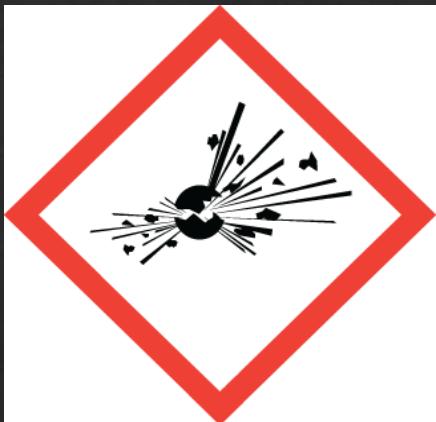
Oxidizers

# Flame



Flammables  
Pyrophorics  
Self-Heating  
Emits Flammable Gas  
Self-Reactives  
Organic Peroxides

# Physical Hazard Pictograms



# Health Hazard Pictograms



# Precautionary Statement Examples

- ❖ **Prevention**

- “Wear protective gloves”

- ❖ **Response**

- “If inhaled remove person to fresh air”

- ❖ **Storage**

- “Store in well ventilated place”

- ❖ **Disposal**

- “Waste must be disposed of in accordance with federal, state and local environmental control regulations”

# Label Example



## 1 Sulfuric Acid

- 2  
3 Danger! May be harmful if swallowed.  
Causes sever skin burns and eye  
4 damage. Fatal if inhaled. Harmful to  
aquatic life.



Do not breathe dust/fume/gas/mist/vapors/spray. Wear protective gloves/protective clothing/eye protection/face protection. Wear respiratory protection.

5

**IF IN EYES:** Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Immediately call a POISON CENTER or doctor/physician.

**In case of fire Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.**

See Material Safety Data Sheet for further details regarding safe use of this product.

6

Sigma-Aldrich 3050 Spruce Street SAINT LOUIS MO 63103 USA Telephone : +18003255832

1 Product Identifier

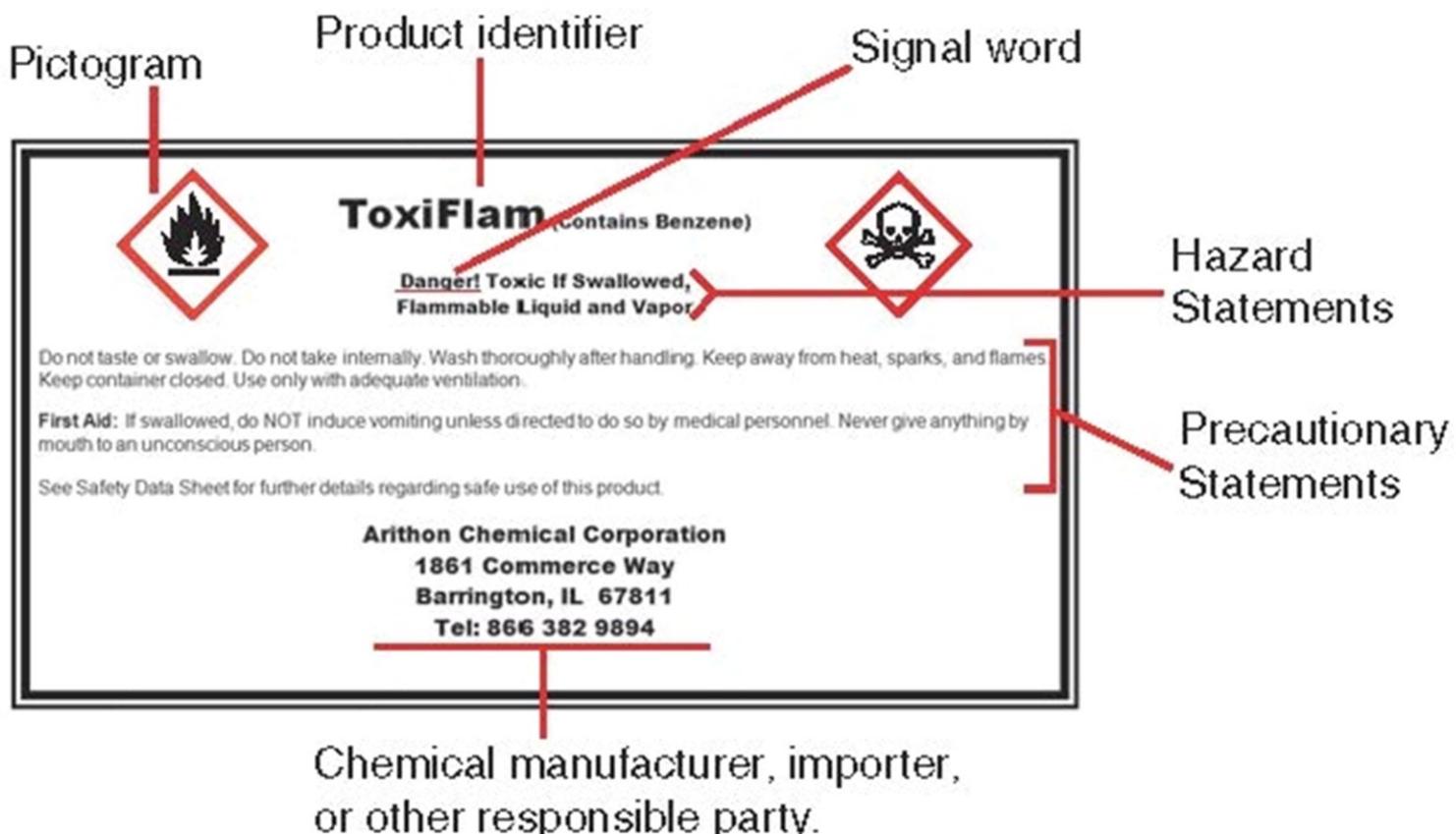
4 Hazard Statements

2 Pictograms

5 Precautionary Statements

3 Signal word, "Danger!"

6 Supplier Information



# Label Example

**GHS Label**

**GHS Material**  
**Danger!**  
Toxic If Swallowed, Flammable Liquid and Vapor



Do not eat, drink or use tobacco when using this product. Wash hands thoroughly after handling.  
Keep container tightly closed. Keep away from heat/sparks/open flame – No smoking. Wear protective gloves and eye/face protection. Ground container and receiving equipment. Use explosion-proof electrical equipment. Take precautionary measures against static discharge. Use only non-sparking tools.  
Store in a cool/well-ventilated place.

**IF SWALLOWED:** Immediately call a POISON CONTROL CENTER or doctor/physician. Rinse mouth.  
In case of fire, use water fog, dry chemical, CO<sub>2</sub>, or "alcohol" foam.

Consult corresponding MSDS for ingredients and handling instructions  
SiteHawk®, 709 Nissan Drive, Smyrna TN 37167 (615) 459-0064

# Label Example

## Product J

(abc chemical)



### Danger

Fatal if swallowed  
Causes skin irritation

#### Precautions:

Wear protective gloves.  
Take off contaminated clothing and wash before reuse.  
Wash hands thoroughly after handling.  
Do not eat, drink or smoke when using this product.

Store locked up.  
Dispose of contents/containers in accordance with local regulations.

IF ON SKIN: Rinse skin with water/shower.  
IF IN EYES: Rinse cautiously with water.  
IF SWALLOWED: Immediately call a Poison Center or  
doctor/physician. Do not induce vomiting.

ABC Chemical Co., 123 Anywhere St., (123) 456-7890  
See the SDS for more information

## Local and Systemic Effects

- Local effects from chemical exposure occur at the site of contact, i.e., eye irritation, skin burns or blistering, respiratory distress, or pulmonary edema.
- Systemic effects occur at a location distant from the point of contact, i.e., liver, CNS, heart, or kidneys.

The toxic action of a health hazard can be divided into acute (short-term) effects and chronic (long-term) effects.

- **Local effects** - stomach irritation and stomach upset.
- **Systemic effects** - an increase in the blood alcohol level, which can cause damage to brain cells.
- **Acute effects** - drunkenness, headache and a hangover.
- **Chronic effects** - permanent liver damage, which can have a latency period of many years.

1. Toxic substances can have different kinds of effects on the body.
2. Local effects occur at the place where the hazardous agent comes into contact with or enters the body.
3. Systemic effects occur inside the body once a hazardous agent has entered the body.
4. Acute effects are usually immediate, obvious, short-term responses to exposure to a hazard. They can be localized to one part of the body, or they can be systemic.
5. Chronic effects develop over time. You may not see any symptoms until many years after the exposure occurred because of long latency periods. Chronic conditions can result from a short exposure, or from repeated contact with a substance or work process. Chronic effects can be localized to one part of the body or systemic.
6. Prevention is the only cure for chronic conditions.
7. Exposure to some hazards can cause both acute and chronic health effects.

Common hazardous substances in the workplace include:

- acids.
- disinfectants.
- glues.
- heavy metals, including mercury, lead, cadmium and aluminium.
- paint.
- pesticides.
- petroleum products.

# NFPA Labeling

NFPA-The National Fire Protection Association



Blue - Health



Red - Flammability



Yellow - Reactivity



White - Other hazards or special handling

SCALE: 0 (No Hazard) to 4 (Extreme Hazard)

*End of lecture!*