

# Basic Industrial Hygiene and Toxicology (CEM Lecture Series – “Terrorism”)

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# Outline

- Basic Chemistry
- Chemical Classification
- Health Hazards
- Basic Toxicology
- Toxicology and other properties of chemicals possibly used by Terrorists

# Basic Chemistry

- Lipid Soluble Compounds (e.g. solvent based)
  - Non-polar, hydrophobic, “organic” contain carbon
  - Absorbed through skin
  - Enter blood stream
  - Cross placental (sometimes), and “blood-brain” barrier
  - “Systemic” (versus local) effects

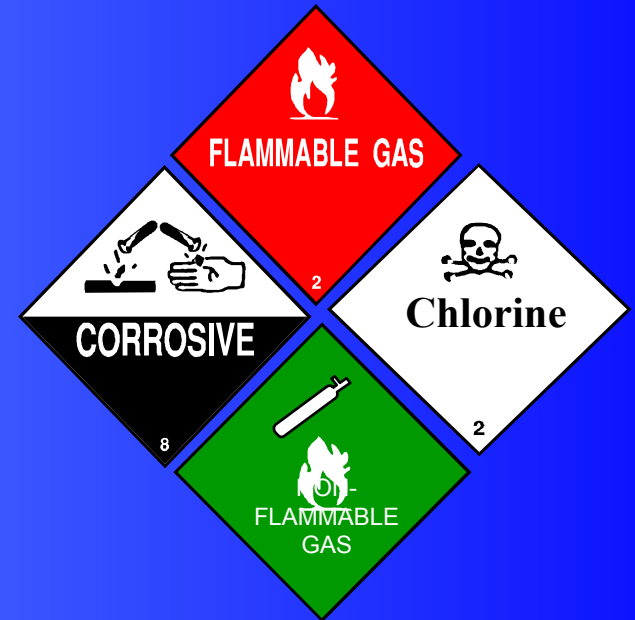
# Basic Chemistry

- Water-Soluble Compounds
  - Polar “hydrophilic” compounds
  - Not absorbed through skin
  - May cause irritation or burning of mucous membranes or skin
  - Typically do not enter lower lung/alveoli

# Basic Chemical Classifications

1. Non-Flammable (Inerts)
2. Corrosive (Acids and Bases)
3. Flammable and Combustible
4. Toxics

(Physical states to consider are gases, liquids and aerosols)



# Corrosives

- Capable of causing visible destruction or irreversible alterations in human skin tissue at the site of contact, or lungs if inhaled

## **Corrosive Acids:**

**Hydrochloric acid**

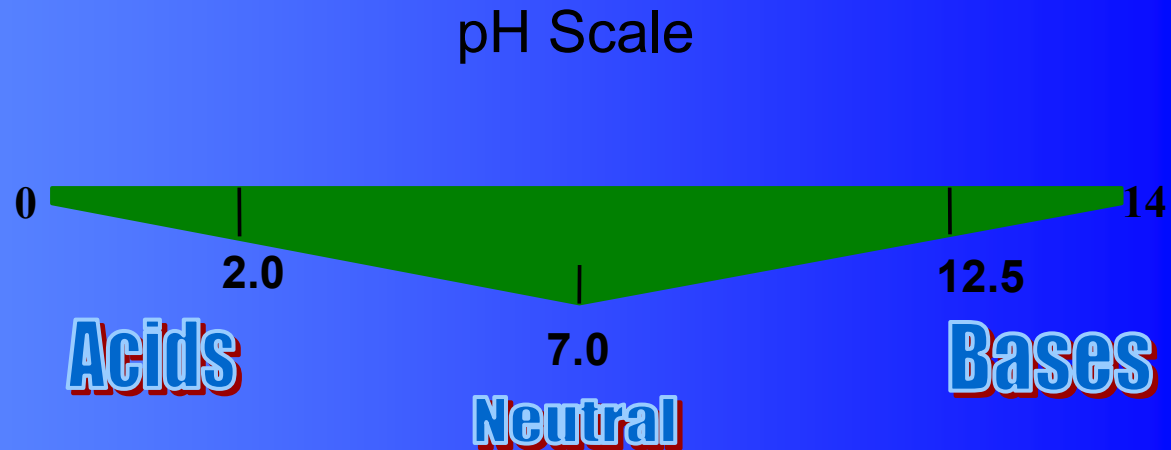
**Hydrofluoric acid**

**Sulfuric acid**

## **Corrosive Bases:**

**Ammonium hydroxide**

**Sodium hydroxide**





# Corrosives

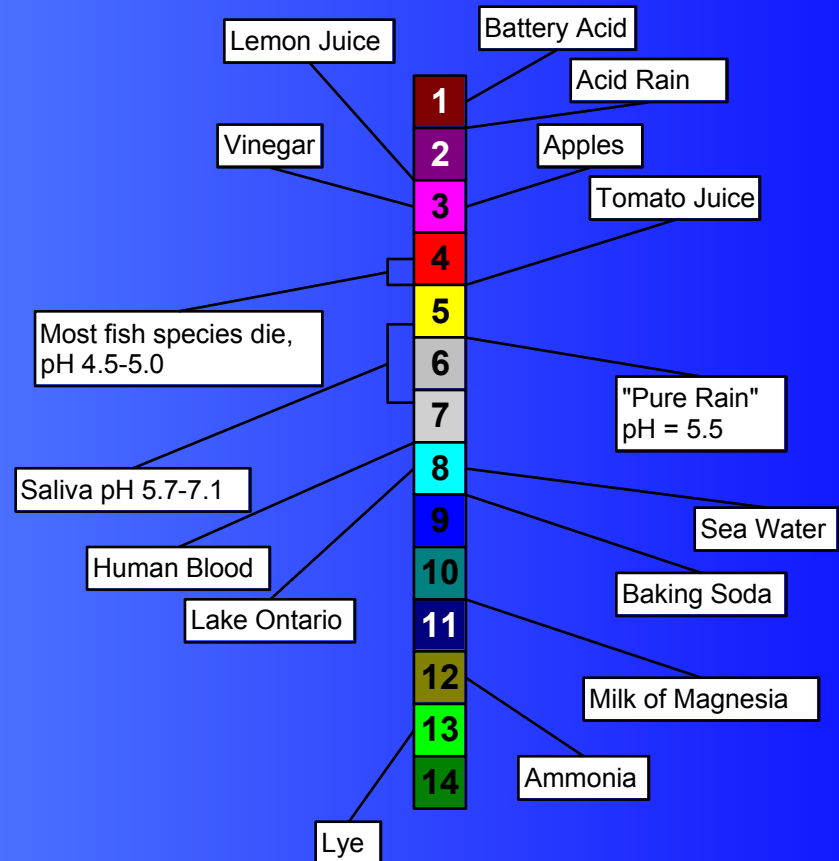
## ■ *Acids:*

- Hydrochloric acid,
- Hydrofluoric acid

## ■ *Bases:*

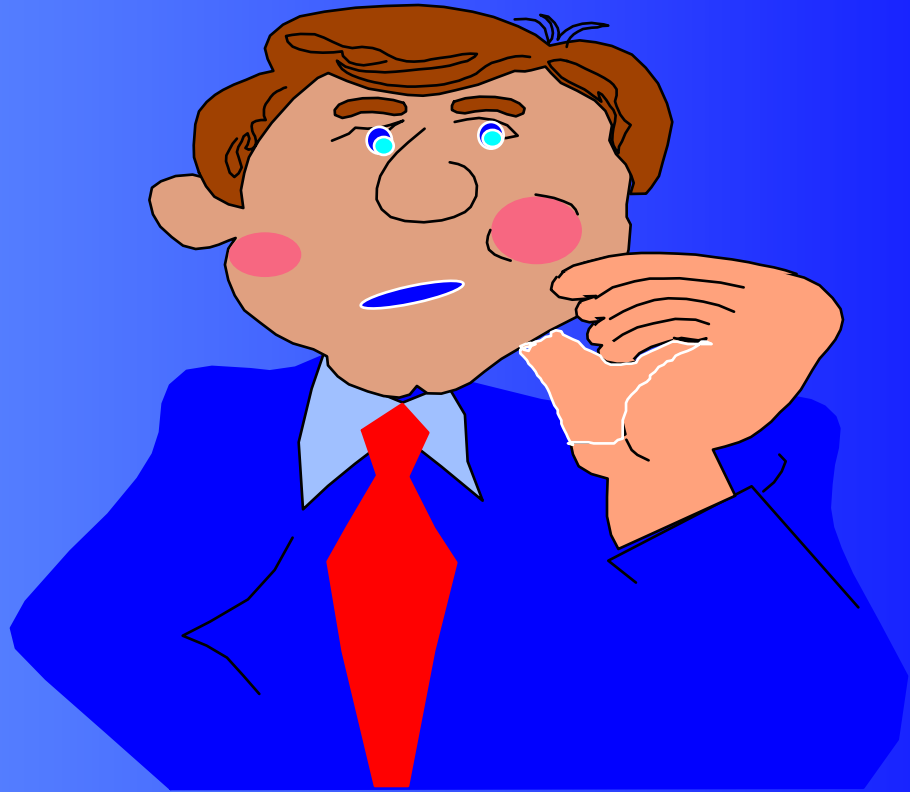
- Sodium hydroxide,
- Ammonia

## pH Scale



# Health Hazards

- Carcinogen
- Sensitizer
- Irritant
- Corrosive
- Toxic
- Highly Toxic
- Poison

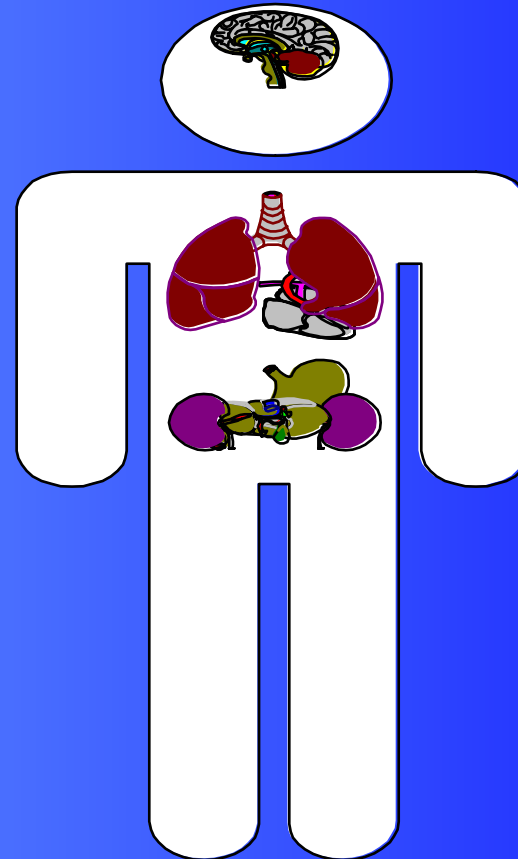


# Routes of Entry

- ◆ Inhalation (Breathing)(effects occur in seconds)
- ◆ Absorption (Through Skin)(effects in 30 minutes)
- ◆ Ingestion (Swallowing)(effects in minutes – hours)

# Target Organs

- Central Nervous System
- Lungs
- Eyes
- Liver
- Kidneys
- Skin



# Health Effects

## **Acute**

Typically SHORT term exposures at High concentrations that show up Quickly.

## **Chronic**

Typically LONG term exposures at Lower concentrations that show up over a Long period of time.

# General Health Effects of Solvent Exposure

- Exposure feels cold
- Dries out the skin by removing oils, greases
- May cause dizziness, headaches, nausea
  - Central Nervous System (CNS) depression
- Gloves must be worn when handling IPA and acetone
  - Latex gloves are not compatible with acetone, use nitrile instead

# General Health Effects of Gases

- Quick onset due to efficient mode of delivery to tissues, bloodstream, and sensitivity of mucous membranes
- Water soluble (e.g. ammonia) cause effects in upper respiratory tract (irritation/coughing)
- Water insoluble (e.g. Hydrogen Sulfide) cause effects in lower respiratory tract (may cause pulmonary edema)

# Factors Determining Chemical Effects

- Dose / effect
- Exposure (concentration and duration)
- Absorption route/ rate

# Health Effects Terminology

## CARCINOGENS

Substances which cause cancer (e.g. vinyl chloride, ionizing radiation)

## HEPATOTOXINS

Can cause **Liver** damage (i.e. Carbon Tet and Nitrosamines).

## NEPHROTOXINS

Can cause **Kidney** damage (i.e. Halogenated Hydrocarbons and Uranium).

## NEUROTOXINS

May affect the **Nervous System** (i.e. Sarin, VX)

## HEMATOPIOETIC

May affect the **Blood System** (i.e. Carbon Monoxide and Cyanides).

## PULMONARY AGENTS

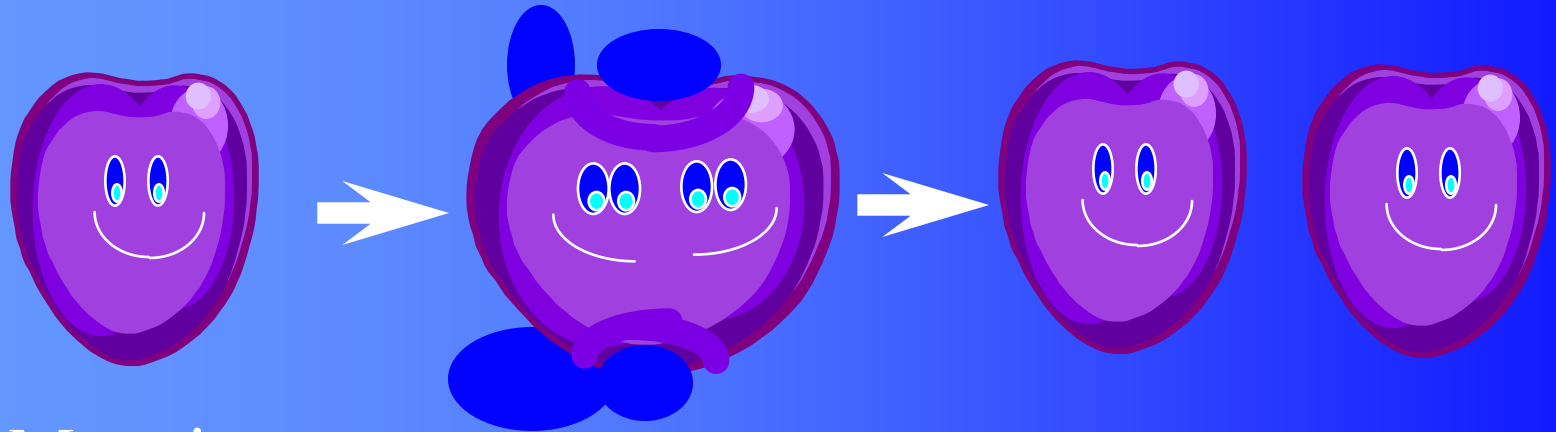
May irritate or damage the **Lungs** (i.e. Chlorine, phosgene, mustard gas)

## CUTANEOUS HAZARDS

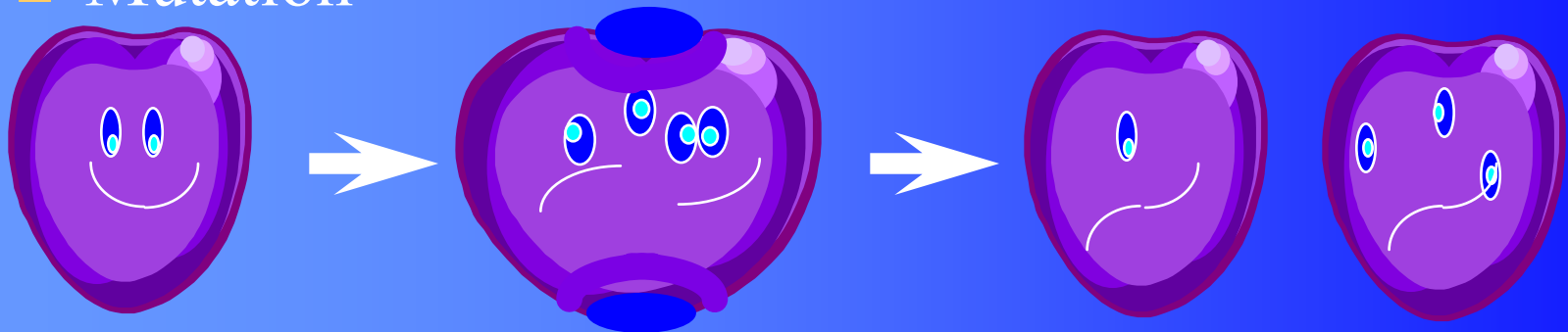
May affect **Skin** tissue (i.e. Ketones - Acetone, MEK).

# Carcinogens, Teratogens, Mutagens

## ■ Normal Cell Division



## ■ Mutation



# Toxicological Terminology

- LD50 – dose required to kill 50% of test subjects
- LC50 – concentration to kill 50% of test subjects
- TLV – guideline for concentration which can be tolerated for 8 hours per day, 40 hours per week
- IDLH – concentration likely to death, immediate or delayed permanent health effects if person cannot immediately escape

# Skin LD<sub>50</sub>

Absorption Lethal Dose Rats



Toxic	200-2000 mg/kg
Highly Toxic	<200 mg/kg
VX	0.1 mg/kg
Sarin	2.5 mg/kg
Parathion	6.8 mg/kg
Malathion	4400 mg/kg

# Inhalation LC<sub>50</sub>

## Inhalation



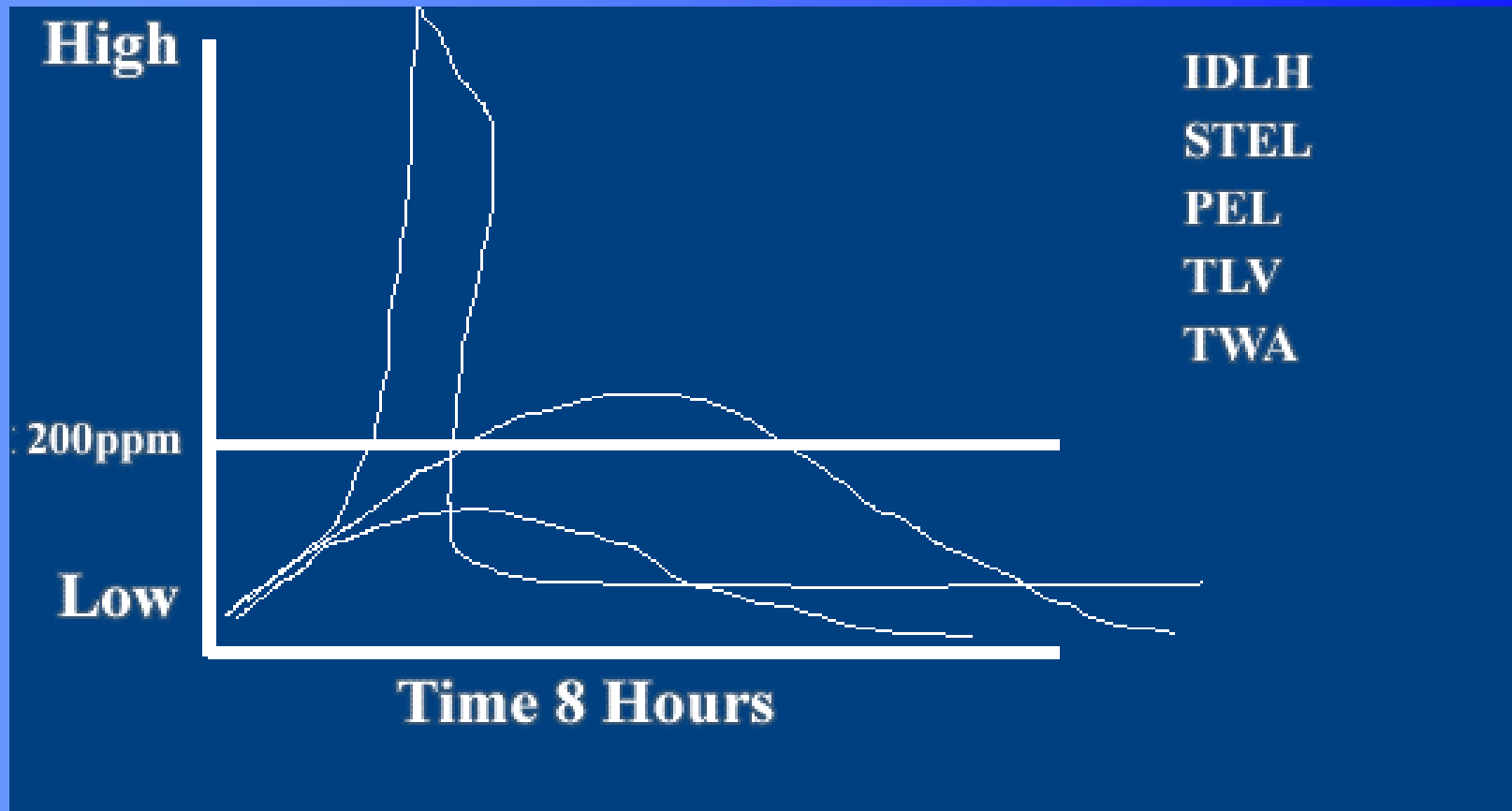
## Lethal Concentration

Toxic 200-2000 ppm

Highly Toxic <200 ppm

Occasionally mg/m<sup>3</sup>

# Immediately Dangerous to Life & Health



# Toxicity of Gases Possibly Used by Terrorists

	<u>TLV</u>	<u>IDLH</u>
● Phosgene	0.1 ppm	2 ppm
● Parathion	0.1 mg/m <sup>3</sup>	10 mg/m <sup>3</sup>
● Paraquat	0.1 mg/m <sup>3</sup>	1 mg/m <sup>3</sup>
● Arsenic	0.5 mg/m <sup>3</sup>	5 mg/m <sup>3</sup>
● Cyanogen	10 ppm	na

# Pesticides Possibly Used for Terrorist Purposes

- Organophosphates
- Arsenicals
- Cyanogens

# Organophosphates

- Organophosphates (e.g. malathion, parathion)(VX, GB (Sarin), GA (Tabun)
  - Acetylcholinesterase inhibition
  - Symptoms include pupil constriction, blurred vision, tearing, abdominal cramps, slurred speech, weakness
  - Diagnosis: red blood cell and serum cholinesterase level
  - Treatment: atropine, PAM, *decontamination* – ONLY by trained professionals in less than 30 minutes

# Arsenicals

- Arsenic
  - Found in pesticides
  - Inhibits cellular respiration through oxygen metabolism
  - May cause contact dermatitis, peripheral neuropathy, anemia and lung, lymphatic and skin cancer

# Cyanogens (CN)

- Toxicology
  - Uses: electroplating, fumigant, chemical syntheses
  - Form Cyanide in the body
  - Inactivates cellular respiration (cell cannot use oxygen)
  - Symptoms: headache, nausea, vomiting, respiratory irritation
  - Treatment: Cyanide kit, oxygen (nitrite, thiosulfate or dicobaltesdetate (combines with CN to form biologically inactive compound))

# More Pesticide Issues

- 46% of all homicidal poisonings analyzed by CDC were caused by arsenicals, cyanide or strychnine others include mercurials, thallium, and paraquat
- EPA has cancelled registration, or requires permits for use or procurement of these
- In the Japanese Sarin incident, over \$30 million was spent, 19 persons killed mainly due to problems encountered with synthesizing the material as well as administering.

# Other Gases Used

- Mustard gas and Tabun (used by Iraq against Iran)
- Exerts toxic effects on skin (blistering) and lungs (pulmonary edema)

# Summary

- Chemicals can be classified by chemical class, physical state, toxicity, target organs and toxic effect
- Chemical classification can be used to predict the way it will behave in the ambient environment, and the potential health effects
- “The dose makes the poison”
- General protection will always be:
  - Quickly leave area of contamination
  - Fresh air, decontamination (building sprinklers?)
  - CPR – qualified medical attention