

# **OCCUPATIONAL & ENVIRONMENTAL POLLUTANTS**

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**DEPT OF PHARMACOLOGY**



# HISTORY



Great Smog of London (1952)



Minimata Disease (1950s)



Chernobyl (1986)

# Occupational Toxicology

- Deals with chemical found in workplace
- Responsible for the following:
  - Identification of Agents
  - Acute and Chronic Diseases
  - Conditions that warrant their use safely
  - Preventive Measures
  - Treatment of Disease
  - Surveillance
- Occupational Safety and Health Standards (OSHS)

# Environmental Toxicology

- Deals with chemicals or pollutants found in the environment that has detrimental effects on living organisms
- Air, Soil or Water
- Product of Industrialization, Technologic Development and Urbanization

# Hazard versus Risk

- Hazard
  - ability of chemical agent to cause injury/disease in a given situation or setting
- Risk
  - expected frequency of the of the occurrence of an undesirable effect arising from exposure to a chemical or physical agent
  - Likelihood that a hazard will cause harm



# HAZARD

is the potential  
to cause harm



when crossing a road,  
cars are a hazard

# RISK

is the likelihood of  
harm taking place



when crossing  
a highway, the risk of an  
accident is high

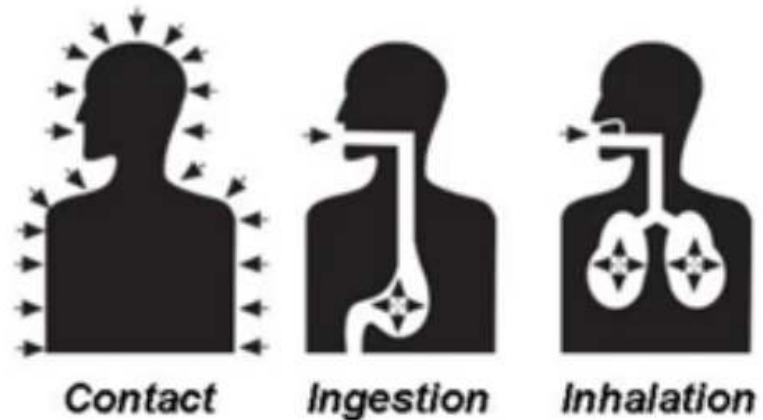
when crossing  
a country road, the risk of  
an accident is low





# Routes of Exposure

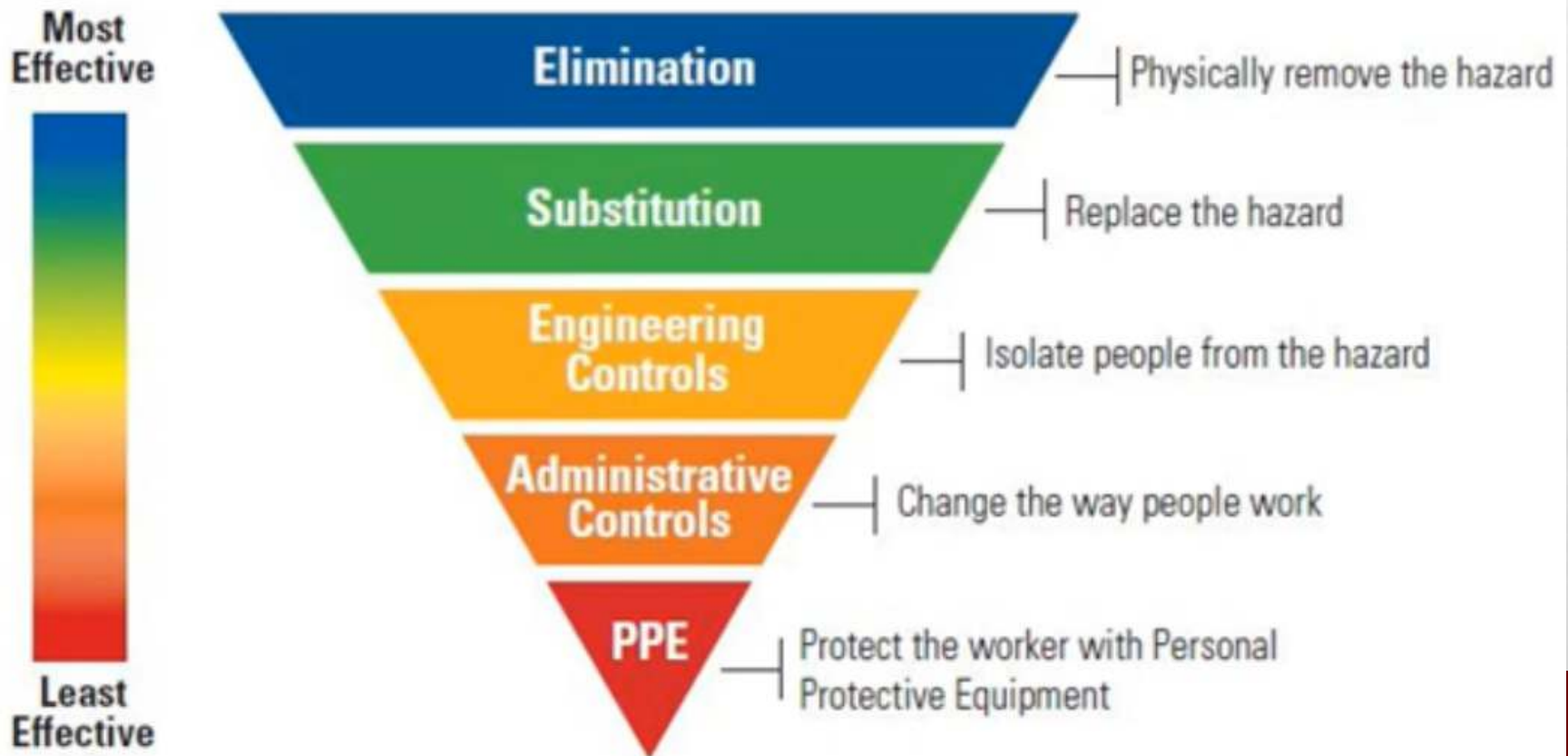
- Inhalational, Transdermal Route are quite common in the industry
- Water and Soil pollutants are absorbed through inhalational, ingestion or transdermal



## Quantity, Duration and Intensity of Exposure

- An exposure to a toxic substance that is absorbed by the target human or animal results in a dose.
- Acute Exposure – single exposure or multiple exposure over a brief period of time (e.g. accidental discharge)
- Chronic Exposure = single or multiple exposure over a longer period of time (e.g. repetitive handling of chemical)

# Hierarchy of Controls

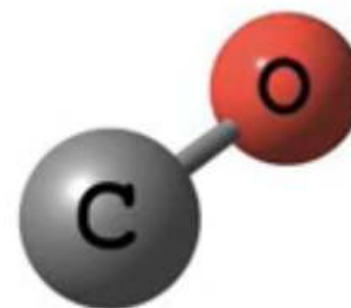


# AIR POLLUTANTS

- Vapors, Aerosols, Smokes, Particulates and Individual Chemicals
- Major Substances:
  - Carbon Monoxide (52%)
  - Sulfur Oxides (14%)
  - Hydrocarbons (14%)
  - Nitrogen products (14%)
  - Ozone (4%)

# Carbon Monoxide (CO)

- Colorless, tasteless, odorless and non-irritating gas
- Byproduct of incomplete combustion
- Unvented kerosene and gas space heaters; leaking chimneys and furnaces; back-drafting from furnaces, gas water heaters, wood stoves, and fireplaces; gas stoves; generators and other gasoline powered equipment; automobile exhaust from attached garages; and tobacco smoke
- Easily absorbed through the lungs
- Exposure may be acute or chronic
- Has teratogenic potential





## Mechanism of Action

- CO combines tightly but reversibly with the oxygen-binding site of hemoglobin (Hb)
- The product formed with this reaction is called Carboxyhemoglobin
- CO has affinity of about 220 times that of oxygen
- Reduced oxygen transfer to the tissues
- Organs with the highest oxygen demand are most seriously affected (Brain, Heart and Kidneys)

# Clinical Effects

- Symptoms of hypoxia
  - Psychomotor impairment
  - Headache and tightness in the temporal area
  - Confusion and loss of visual acuity
  - Tachycardia, tachypnea, syncope, and coma
  - Deep coma, convulsions, shock and respiratory failure
- Aggravated by:
  - Heavy labor
  - High Altitude
  - High Ambient Temperature
  - Smoking exposure
  - Cardiorespiratory diseases

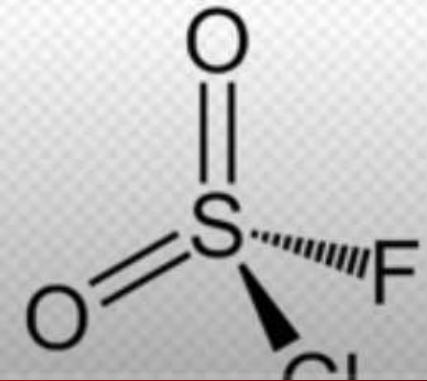


## Treatment

- First step: Remove from source
- Oxygen is the specific antagonist for CO
- High concentrations of oxygen for a short amount of time only
- Hypothermic therapy
- Neuropsychological and motor dysfunction persists for a long time after treatment

# Sulfur Dioxide (SO<sub>2</sub>)

- Colorless irritant gas
- Generated primarily by the combustion of sulfur-containing fossil fuel
- The principal source of urban SO<sub>2</sub> is the burning of coal, domestic heating, high-sulfur transportation and coal-fired power plants



## Mechanism of Action

- Because of its high solubility, when  $\text{SO}_2$  contacts moist membranes, it transiently forms sulfurous acid.
- Sulfurous acid is a severe irritant on the eyes, mucous membranes, respiratory tract and skin
- 90% of inhaled form is absorbed in the Upper Respiratory tract causing Acute Irritant Asthma
- The phenomenon of adapting to irritating concentrations has been reported in workers

## Clinical Effects and Treatment

- Signs and symptoms of eye, nose and throat irritation, reflex bronchoconstriction and increased bronchial secretions
- May initiate or exacerbate Bronchial Asthma
- Delayed-onset pulmonary edema
- Treatment is supportive, non-specific



## Nitrogen Oxides (NO<sub>2</sub>)

- Brownish irritant gas associated with fires
- Farmers exposed to fresh silage
- Miners exposed to diesel equipment
- Today, the common causes are automobile and truck traffic emissions

## Clinical Effects and Treatment

- Silo-Filler's Disease, Non-allergic Asthma, "Twitchy-airway disease"
- Acute: Irritation of eyes and nose, cough, mucoid or frothy sputum production, dyspnea and chest pain; Pulmonary edema, fibrotic destruction of terminal bronchioles
- Chronic: Emphysematous changes
- Treatment: Supportive, non-specific

## Ozone (O<sub>3</sub>) and Other Oxides

- Bluish irritant gas naturally found in the earth's atmosphere
- Produced primarily when fossil fuel are burned or when some chemicals evaporate
- Emitted from power plants, motor vehicles and other sources of high-heat compounds
- Ozone in the workplace is generated by high-voltage electrical equipment and around ozone producing devices like air and water purification systems
- Found in agriculture as well

# Mechanism of Action

- Irritant of mucous membranes
- Produces upper respiratory tract irritation to deep lung irritation with pulmonary edema
- Formation of reactive free radicals





## Clinical Effects and Treatment

- Shallow, rapid breathing and decrease in pulmonary compliance
- Acute: Irritation and dryness to throat, changes to visual acuity, substernal pain and dyspnea, ARDS
- Chronic: Chronic Bronchitis, Bronchiolitis, Emphysema
- Treatment: Supportive, non-specific



## SOLVENTS



## Solvents

- Halogenated Aliphatic Hydrocarbons
- Aromatic Hydrocarbons

# Halogenated Aliphatic Hydrocarbons

- Also called Halohydrocarbons
- Once found in industrial solvents, degreasing agents and cleaning agents
- Carbon tetrachloride, trichloroethylene, chloroform, tetrachloroethylene and 1,1,1-trichloroethane
- Most are classified as known or probable human carcinogens
- Freon, a fluorinated aliphatic, causes severe damage in the ozone layer in the troposphere



## Clinical Effects

- Human Carcinogens - some are associated with renal, prostate and testicular cancer
- CNS depression, kidney injury, liver injury, cardiotoxicity, arrhythmia
- Chronic Exposure in the Workplace: Impaired memory, peripheral neuropathy
- Treatment: Supportive, non-specific



## Aromatic Hydrocarbons

- Benzene
- Toluene
- Xylene

# Aromatic Hydrocarbons: Benzene

- Important component of gasoline
- One of the most widely used industrial chemicals in the world
- Used for its solvent properties
- Acute Exposure: CNS Depression, Nausea, Euphoria, Locomotor Problems and Coma; Vertigo, Drowsiness and Headache
- Chronic Exposure: Bone Marrow Injury (Aplastic Anemia, Leukopenia, Pancytopenia, Thrombocytopenia etc)
- Pluripotent Bone Marrow Stem Cells are the target
- Potent Clastogen
- Treatment: Supportive, non-specific

## Aromatic Hydrocarbon: Toluene

- Also known as Methylbenzene
- paint thinners, nail polish remover, glues, and correction fluid; explosives
- No myelotoxic properties
- CNS depressant, skin and eye irritant, fetotoxic
- Associated with rapid loss of consciousness, severe fatigue, ataxia

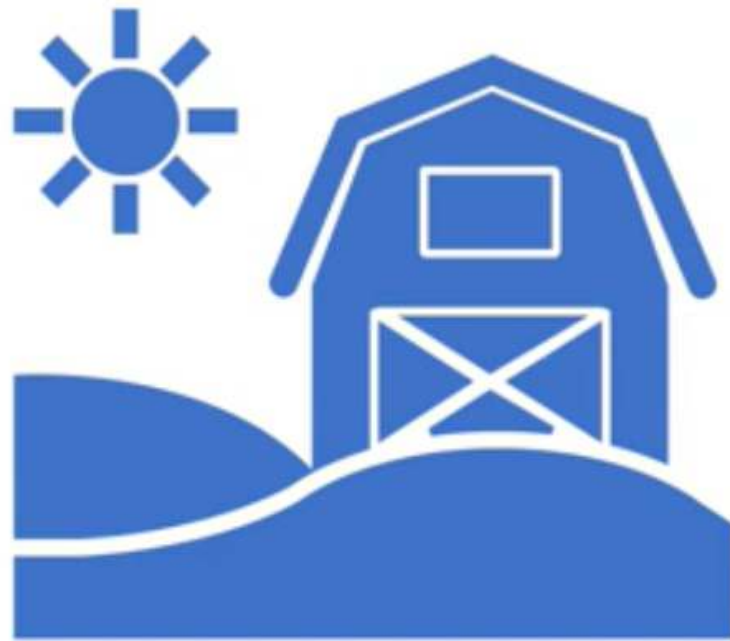


## Aromatic Hydrocarbons: Xylene

- Also known as dimethylbenzene
- Colorless, sweet-smelling agent
- Substitute for benzene in solvent degreasing operations
- No myelotoxic properties
- CNS depressant, skin irritant



Pesticides

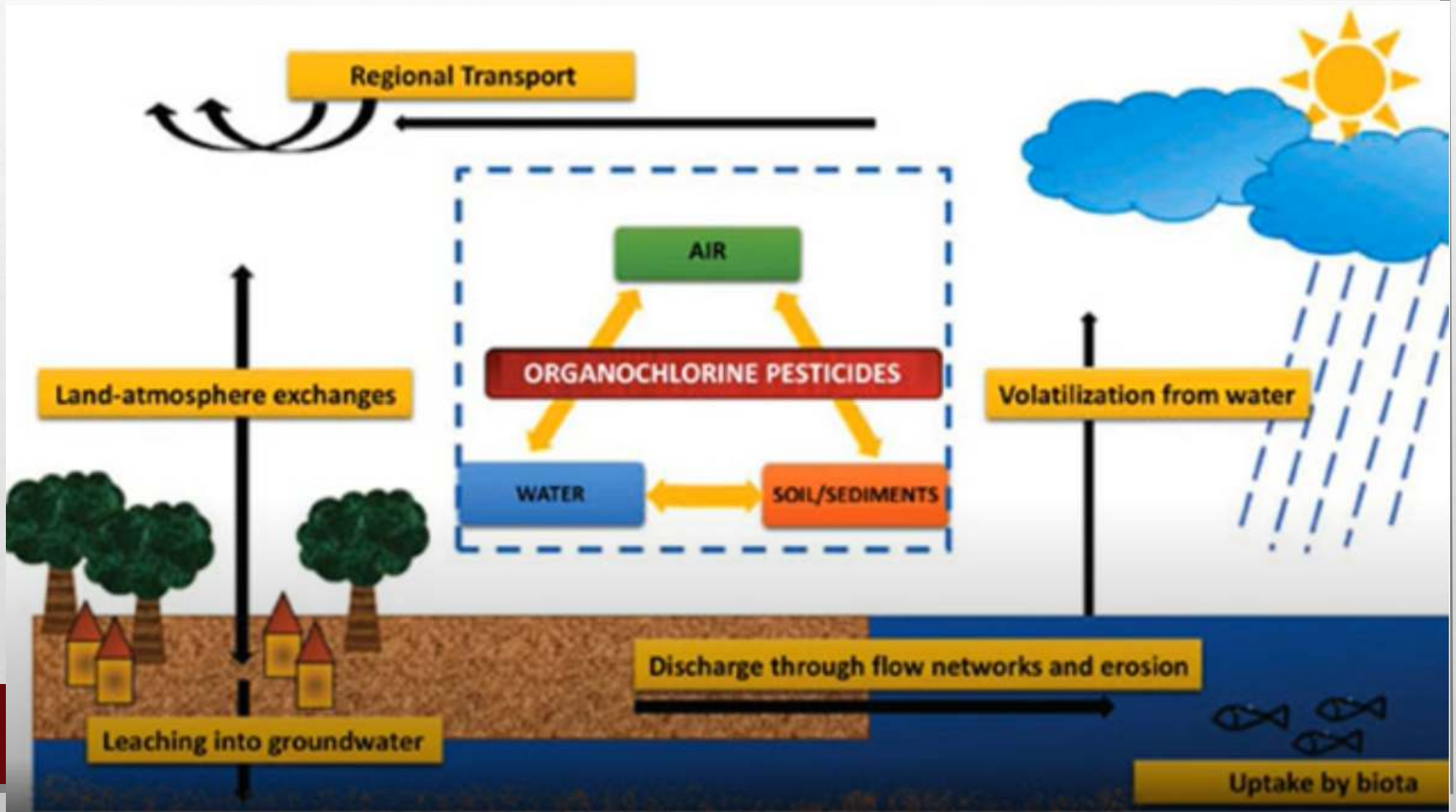


## Pesticides

- Organochlorine Pesticides
- Organophosphorus Pesticides
- Carbamate Pesticides
- Botanical Pesticides

# Organochlorine Pesticides

- Aryl, carbocyclic or heterocyclic compounds with chlorine substituents
- Four Classes: DDT (chlorophenothane) and analogs, benzene hexachlorides, cyclodienes and toxaphenes
- Largely abandoned due to severe environmental damage due to persistence in environment
- Known endocrine disruptors in humans and animals
- DDT – domestic mosquito elimination in malaria-infested regions of Africa
- Long-term effects poorly understood



## Mechanism of Action and Clinical Effects

- MOA: interfere with inactivation of the sodium channel in excitable membranes and cause rapid repetitive firing in most neurons; calcium ion transport is inhibited
- DDT – Tremor is the first manifestation
- Carcinogenic potential but more long-term studies are required

# Organophosphorus Pesticides

- Used against large variety of pests
- Either via direct contact or via plant systemics
- Based on warfare chemicals like sarin, soman and tabun
- Absorbed via the skin, respiratory and GI tract
- In the environment, not considered a persistent pesticide

## Mechanism of Action and Clinical Effects

- MOA: inhibition of acetylcholinesterase through phosphorylation of the esteratic state
- M-U-D-D-L-E-S: miosis, urination, diarrhea, diaphoresis, lacrimation, excitation of the central nervous system, and salivation
- If not reversed, patients will develop neuromuscular transmission failure – cardiorespiratory failure, weakness of respiratory muscles and death
- Specific treatment and useful antagonists are available (i.e. physostigmine, pralidoximine)



## Environmental Pollutants

- Polychlorinated and Polybrominated Biphenyls
- Perfluorinated Compounds
- Endocrine Disruptors
- Asbestos

# Polychlorinated and Polybrominated Biphenyls

- Highly halogenated biphenyl compounds
- Used for insulation, fire retardancy
- Mass production resulted in enormous environmental problems
- Very toxic and now banned for use
- Food is the major source of PCB Residues in humans
- Potent endocrine disruptors; associated with reproductive and teratogenic effects on animal studies
- Persists in the environment

# Perfluorinated Compounds (PFCs)

- Coolant materials in air-conditioning systems
- Used as oxygen-carrying materials in clinical studies
- Used as heat-, stain-, and stick-resistant coatings for cookware, fabrics and other materials (i.e. Teflon)
- Had deleterious effect in the ozone layer of the atmosphere
- Persistent environmental chemical



# Perfluorinated Compounds (PFCs)

- Ingested and inhaled by humans
- Human half-life is 3 years
- Potent endocrine disruptor
- Long-term adverse effect on reproductive function, cellular proliferation and other cellular homeostatic mechanisms
- Associated with proliferation of breast cancer cells; renal, ovarian, prostate and Non-Hodgkin's lymphoma
- Associated with cholesterol and uric acid abnormalities
- Polymer Fume Fever

# Asbestos

- Widely used in industry for over 100 years
- Causes progressive fibrotic lung diseases (asbestosis), lung cancer, mesothelioma
- Synergistic effect with cigarette smoking and exposure to radon daughters
- Mechanism for cancer is not well-defined
- Many countries has banned Asbestos

**Thank u....**