Environmental Chemistry & Toxicology

(Lecture 2)

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Lecture 2:

Environmental Toxicology and Chemistry

- Poisons
- Toxicology
- Chemistry of toxicology
- Toxicity
- Hazard and risk
- Major toxic hazards

Poisons

- Toxic means poisonous
- *Toxic* from Greek word *toxikon* referring to a bow (poisoned arrows)
- Toxic materials in plants, micoorganisms, animals, minerals etc.
- Antiobiotics are produced by microroganisms for defense purposes
- Many plants release allelochemicals – prevent other plants from growing near them
- Invertebrate animals release toxic substances for defense
- People died from poisoning, including tobacco and alcohol

Causes of death in the United States

Cause	1970	1980	1990
Motor vehicles	54,633	53,272	46,814
Falls	16,926	13,294	12,313
Guns	2,406	1,955	1,416
Poisons, accidental	5,299	4,331	5,803
Poisons, suicide	6,584	5,453	5,424

Deadly toxic materials

- Total exposure to toxic materials is worldwide phenomena
- 715,000 toxic exposure in US (1992)
- More than 3 million poisoning cases, annually
- Accidental poisoning is common to wild and domestic animals

Environmental toxicology

- Toxicology is the science of poisons
- "Poison as a substance that causes illness, injury and death … by chemical means"
- "Toxicology as dealing with the occurance, physical and chemical properties, effects and detection of poisons"
- "Environmental toxicology" includes occupational toxicology
- Emphasis on

  (1) occurance, availability and form of toxic chemicals

  (2) exposure

  (3) comparative effects & mechanisms of action in the broad range of exposed species, including humans

Environmental chemistry

- Poisons are chemicals, exposure is governed by chemical forces, and both action of poisons and an organism's ability to protect itself are largely a matter of chemistry.
- Environmental chemistry is concerned with the sources, identity, levels, reactions, transport and fate of chemical species in water, soil and air environments – provide exposure information for evaluation of toxicity and risk.

Toxicity

- Intoxication is the scientific terms for poisoning
- Dose-response relationship
- The dose makes the poison
- Selective toxicity – one species can be affected by a poison while another seemingly is not
- Selectivity is a necessary feature of medicines and pesticides, and many weed killers, e.g. are almost non-toxic to mammals because they kill plants by such non-animal processes as photosynthesis
- Intoxication is common to all living organisms, from bacteria to people

Human intoxication

- Legal drugs and medicines cause 70% of both accidental and intentional poisoning deaths in humans
- Emphysema (lung damage) and cancer of lungs and mouth, due largely to smoking
- Age: 1-2 yrs more susceptible to intoxication
- Sex: Girl more susceptible
- Medicines, esp. pain relievers such as aspirin are responsible (50%); household cleaners, cosmetics and toxic plants account for about 10% each
- Water polluters, esp. nitrate and other inorganic toxicants, affects large number of people

Domestic animals

- Dogs, cats, cows, horses ate mainly poisoned by pesticides (insecticides, herbicides, fungicides or rodenticides)
- Other causes: veterinary drugs and toxic plants
- Eating plastics, chocolates, poisonous toads also listed as dangerous.

Hazard & Risk

- Hazard = potential for harm & its magnitude equals to severity of the expected consequences
- Risk = function of the magnitude of a hazard & probability of its occurrence

Example:

- "A community that expects an oil spill once a year faces the same hazard but at 10 times the risk as one that has a spill only once every 10 years"

Cancer risk in everyday living

Activity	Frequency	Risk	Cause
1 transcontinental flight	Per year	1	Cosmic radiation
Medical X-ray	Each	20	X-radiation
Drink 1 pint of milk daily	Per year	2	Radioactive stronium
Smoke 1 cigarette	Each	1	PAH
Share a smoker's room	Per year	20	PAH
Drink 1 diet cola daily	Per year	10	Artificial sweetener
Drink 1 ppb of TCE in water	Per year	<0.1	Pollution

PAH = polycyclic aromatic hydrocarbons; TCE = Tricholoroethane

Major toxic hazards … (1)

Class	Examples
Polycyclic aromatic hydrocarbons	Benzo(a)pyrene
Biotoxins	Urushiols, nicotine, shellfish poisons, alfatoxins, toadstool toxins
Reactive gases	CO, HCN, Cl_2, SO_2/SO_3, H_2S, O_3
Metal & metalloid compounds	As, Pb, Hg, Cd, Ni, Cr, Cu, Sn
Chlorinesterase inhibitors	Organophosphate insecticides, carnamate insecticides, solanine

Major toxic hazards … (2)

Class	Examples
Halogenated hydrocarbons	Carbon tetrachloride, chlordane, chloroethylenes, DDT, dichloromethane, dieldrin, HCB, methyl bromide, TCDD
Polycyclic aromatic hydrocarbons	Benzo(a)pyrene
Solvents	Benzene, methanol, MIBK
Miscellaneous	Aspirin, penthachlorophenol, phenol, formaldehyde, ethylene glycol

Major toxic hazards

- Polycyclic aromatic hydrocarbons (PAH) are carcinogens, found in smoked and broiled foods, tar, used motor oil and asphalt
- Natural intoxicants from plants include urushiol, the rash-producing biotoxin of poison oak and poison ivy and nicotine found in wild and cultivated tobacco.
- Pesticides that effect nerve impulse transmission (cholinesterase inhibitors)
- Natural cholinesterase inhibitor solanine in potatoes poison human and animals
- Metal and metalloids are classic poisons

References

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