Environmental health and toxicology

• Assess environmental factors that influence [human] health and quality of life
• For example:
  – DDT and bald eagles: weaken the egg shells
  – Pesticides

Types of environmental hazards

• Physical: occur naturally and pose health hazards; UV radiation from sunlight
• Chemical: synthetic and natural chemicals; pesticides
• Biological: ecological interaction among organisms; infectious diseases
• Cultural: behavioral and social (lifestyle) hazards; smoking, location

Examples of environmental hazards

• Outdoors:
  – Vehicle exhaust
  – Industrial pollution
  – Photochemical smog
  – Pesticide drift
  – Dust and particulates
• Water:
  – Pesticide and herbicide runoff
  – Nitrates and fertilizer runoff
  – Mercury, arsenic, and other heavy metals
• Food:
  – Natural toxins
  – Pesticide and herbicide residues
• Indoors
  – Smoke (including 2nd hand)
  – Radon
  – Lead
  – Asbestos
  – Toxicants in plastics and consumer products
  – Dust and particulates
Contamination
• Berkeley Pit – former open pit copper mine
  – Opened 1995, closed 1982
  – 1 mile long x ½ mile wide x 1,780 feet deep
  – Water pumps turned off in 1982 – water slowly
    filling pit to natural water table level, could reach
    level ~2020, then flow will reverse
  – Superfund site

Berkeley Pit
• Water dissolves pyrite and sulfide in the rock
• Water has pH of 2.5, contains dissolved
  heavy metals, some in enough quantity to be
  mined from the water; also arsenic and
  sulfuric acid
• Toxic to life – flock of snow geese that
  landed in pit died

Indoor environmental hazards
• Lead poisoning: ingestion damages brain,
  liver, kidney, and stomach; can cause death;
  comes from ingesting water passing through
  old lead pipes; also in old paint
Asbestos

- Naturally occurring mineral used in buildings as an insulator (heat, cold, sounds, and fire)
- When inhaled – become lodged in lungs, where body attacks it, scarring lungs
- Where mined, mineral became airborne covering everything
  - Wide spread asbestos contamination
  - Libby, Montana

Libby, Montana

- Vermiculite, an ore, mined since 1919
  - Nonflammable material used in insulation across country
  - Contained fibrous tremolite asbestos
  - Workers lived in town
- Newspaper articles in 1999 highlighted connections between deaths, illnesses, and asbestos
  - Air samples confirmed asbestos
  - EPA started cleanup in 2000

Libby, Montana

- Whole town contaminated
  - Over 270 deaths thus far in area attributed to asbestos
  - Lung-related illnesses/deaths
- Superfund site – $300+ million thus far on cleanup
- Prosecution of mining company unsuccessful
Other indoor toxins

- Polybrominated diphenyl ethers (PBDEs)
- Recently recognized issue
- Fire-retardant compound used in TVs, computers, plastics, furniture
  - Slowly released during lifetime of products
- Affects thyroid, cause cancer, and affect brain and nervous system
- Banned by EU in 2003, no action in US

Toxicology

- Science that examines the impacts of poisonous substances on humans and other organisms
- Toxic substances, natural and synthetic, part of environment
  - Not all are harmful but extensive testing on the long-term effects of them hasn’t been completed on most of them

Toxicology

- Up until the 1960s, public (and scientific) awareness as to the hazards of pesticides was minimal
- Changing event: 1962 publication of Silent Spring by Rachel Carson, scientist and naturalist
  - Showed through series of scientific studies, medical case histories, and data synthesized that DDT was harmful
DDT
• Pesticide used extensively, including spraying public areas, neighborhoods
  – Overriding assumption that it was not harmful

• After book’s publication, attempt was made to discredit Carson (personally) and her findings.
  – Generated public awareness and social change
  – DDT banned in 1973 - US still manufactures and exports DDT

Types of Toxicants
• Carcinogens – cause cancer; may take a long time to develop
• Mutagens – causes mutations
• Neurotoxins – attack central nervous system; include heavy metals
• Allergens – over-activate immune system
• Endocrine disruptors – interfere with hormone system; new toxicant
Endocrine disruptors

- Hormones stimulate growth and development; regulate brain function, appetite, and behavior
  - Can have an effect at a very low level of exposure
- First documented with DDT
- Some controversy associated with experimental results
- Companies and countries responding to reports
  - Estrogen mimics bisphenol-A (BPA) used in plastic products
    - Linked to birth defects in mice
    - Products now appearing BPA-free

Toxicants in system

- Move through system in specific paths
- Chemicals tend to be soluble in water, leached into soil, and also transported by air
  - Become concentrated in "sinks"
    - Some are absorbed, others degraded or discarded in plants or animals
  - Move up the food chain
  - Bioaccumulation: build up of toxicants in animals
Bioaccumulation

• Transferred to other organisms as you move up the food chain
  – Prey takes in any stored toxicants
  – Concentrations become magnified
    • Biomagnification
      • Example: DDT – birds of prey ended up with high concentrations because DDT entered water → algae → plankton → small fish → bigger fish → fish-eating birds
      • Resulted in a decline of many species from 1950s to 1970s
        – Peregrine Falcon in eastern US
        – Brown pelican from everywhere but Florida
        – Bald eagle – neared extinction in lower 48 states
        – Eggshells became thinned – breaking too early

Exposure/Risk

• Difficult to measure risk
• Differences in exposure and how to analyze detrimental effects when combined with other interactions
• Acute exposure (high exposure, short time) easier to study vs. chronic exposure (long term, short dose exposure)

Regulation

• In U.S., majors agencies: FDA, OSHA, and EPA
  – FDA: regulates food, food additives, cosmetics, drugs, and medical devices
  – EPA: regulates pesticides, some synthetic chemicals
  – OSHA: regulates exposure
1976 Toxic Substances Control Act (TSCA)

- Allows EPA to monitor 75,000 industrial chemicals
- Problem with regulation: must have proof of toxicity before it can look for toxicity
  - Only 10% of chemicals have been screened for toxicity
  - 2% tested for carcinogenicity
  - 1% regulated
  - Fewer than 1% tested for endocrine, nervous or immune system damage

International Regulation

- Stockhom Convention on Persistent Organic Pollutants 2001
  - POPs – toxic carbon-based chemicals that persist in environment
  - Often cross international boundaries
  - Initially aims to end the use and release of 12 of the most dangerous
    - Has guidelines for ending usage
  - US NOT a signee

Status of ratification
REACH

• Regulatory, Evaluation, Authorization, and Restriction of Chemicals
• EU program
  – Shifts burden of proof for testing chemical safety from government to industry
  – Began in 2007
  – Predicted costs to industry between $3-7 billion but health benefits to people over 30 years at $67 billion