Chapter 7
Human Health and Environmental Toxicology

Overview of Chapter 7

- Human Health
  - Health issues in developed countries
  - Health issues in developing countries
- Environmental Pollution and Disease
  - Environmental Contaminants
  - Endocrine Disrupters
- Determining Health Effects of Pollutants
- Ecotoxicology
- Risk Assessment

Human Health

- Two indicators of human health
  - Life expectancy- how long people are expected to live
  - Infant mortality- how many children die before age of 1 year

Health Issues in Highly Developed Countries

- By many measures- health is good in these countries
  - Great sanitation
  - Few childhood diseases
- Average life expectancy
  - Men = 75 years
  - Women = 80 years
- Leading causes of death in US
  - Cardiovascular disease
  - Cancer
  - Chronic Obstructive Pulmonary Disease (of the lungs)

Health Issue in Highly Developed Countries

- Premature deaths caused by lifestyle
• Poor diet
• Lack of exercise
• Smoking

- **Obesity is big problem**
  - Body Mass Index (BMI)
    - \( \frac{\text{Weight} \times 740}{(\text{height (in)})^2} \)
    - < 18.5 is underweight
    - 18.5-24.9 is healthy weight
    - 25-29 is overweight
    - > 30 is obese

### Health Issues in Developing Countries

- **Biggest problems**
  - Malnutrition, unsafe water, poor sanitation

- **Life Expectancy**
  - Overall is 65 years
  - Very poorest developing countries = 45 years
    - Most of these countries have high AIDS epidemics

- **Childhood mortality is high (18% of deaths)**
  - Diarrheal diseases
  - Malnutrition
  - Malaria
  - AIDS/HIV

### Emerging and Reemerging Diseases

- **Emerging Disease** - not previously observed in humans
  - Usually jumps from animal host
  - Ex: AIDS, lime disease, West Nile Virus

#### Reasons for Emergence/Reemergence

- Evolution of disease so it can move to human host
- Evolution of antibiotic resistance in disease
- Urbanization and overcrowding
- Increased pop. of elderly- susceptible to disease
- Pollution and environmental degradation
- Growth in international travel and commerce
Poverty and social inequality

Environmental Pollution and Disease

- Often difficult to link pollutants to their effects on people
  - Persistence
  - Bioaccumulation
  - Biomagnification

Persistence

- A characteristic of certain chemicals that are extremely stable and may take many years to be broken down into simpler forms by natural processes
  - Synthetic chemicals (those not found in nature)
  - Ex: DDT
- Natural decomposers (bacteria) have not evolved a way to break it down

Bioaccumulation

- The buildup of a persistent toxic substance in an organism's body, often in fatty tissues
  - Synthetic chemical do not metabolize well
  - They remain in the body for extended periods of time

Biomagnification

- The increased concentration of toxic chemicals in the tissues of organisms that are at higher levels in food webs
- Diagram is example of biomagnification of DDT

Endocrine Disrupters

- A chemical that mimics or interferes with the actions of the endocrine system in humans and wildlife
  - i.e. It effects the ability of the hormones in the organisms to function properly
- Examples include:
  - PCBs, Dioxins
• Heavy metals - lead and mercury  
• DDT

- Animals exposed to these chemicals have altered reproductive development and are often sterile

**Endocrine Disrupters**

- Case Study: 1980 chemical spill into Lake Apopka, FL  
  - Male alligators began to exhibit low testosterone levels and high estrogen levels

**Endocrine Disrupters and Humans**

- Infertility and hormonally related cancers are increasing  
  - Breast cancer and testicular cancer

- Phthalates have been implicated as potential endocrine disrupters  
  - Common ingredient in: cosmetics, fragrances, nail polish, medication, toys, food packaging

- Cannot make a link between endocrine disrupters and human illness  
  - Too few studies have been performed

**Determining Health Effects of Pollutants**

- Toxicology is the study of the effect of toxicants on the human body  
  - Toxicant- chemical with adverse human health effects

- Acute toxicity  
  - Adverse effects occur within a short period after exposure to toxin

- Chronic toxicity  
  - Adverse effects occur some time after exposure, or after prolonged exposure to toxin  
  - Symptoms often mimic other diseases- hard to assess source

**Toxicity**

- Toxicity measured by dose and response  
  - Dose: amount that enters that body of an exposed organism  
  - Response: the amount of damage caused by a specific dose
- **LD$_{50}$**
  - Lethal dose to 50% of the test organisms
  - Smaller the LD$_{50}$, the more lethal the chemical
  - Determined for all new synthetic chemicals

**Toxicity**

- **ED$_{50}$**
  - Effective dose to 50% of the test organisms
  - ED$_{50}$ causes 50% of the population to exhibit whatever effect is under study

- **Dose-Response Curve**
  - Illustrates the effect of different doses on a population
  - Threshold Level
    - Maximum dose with no measurable effects

**Children and Chemical Exposure**

- Children more susceptible to chemicals
  - Weigh less than adults
  - Bodies are still developing
  - Play on floors and lawns
    - Exposed to cleaning products and pesticides
  - Put things into their mouths

- **Diagram**
  - Children in foothills not exposed to pesticides
  - Children in valley were exposed

**Identifying Cancer Causing Substances**

- **Toxicologist**
  - Dose rats with varying levels of chemicals to see if they develop cancer
  - Difficult to extrapolate results to humans

- **Epidemiologists**
  - Look at historical exposure of groups of humans
  - See if exposed group have increased cancer rate
Chemical Mixtures

- Most studies look at one chemical, but humans tend to be exposed to chemical mixtures
  - Ex: automobile exhaust
- Chemical Mixtures interact by
  - Additivity
  - Synergy
  - Antagonism
- These studies are expensive and take a while to complete

Chemical Testing

Ecotoxicology

- Dilution Paradigm is not valid
  - “Dilution is the solution to pollution”
- Boomerang Paradigm is accepted
  - “What you throw away can come back and hurt you”
- Ecotoxicology
  - The study of contaminants in the biosphere and their harmful effects on ecosystems
  - Helps policy makers determine costs and benefits of industrial and technological “advances”
    - And how they often adversely effect ecosystems

Case Study: The Ocean

- Land based nutrient and pollution runoff into ocean is affecting microorganisms
- Ex: Red Tide
  - Red pigmented poisonous algal blooms
  - Toxins kill off fish and make humans sick

Risk Assessment

- Risk- probability that a particular adverse effect will result from some exposure or condition
We assess risk daily with four steps
  • Hazard identification
  • Dose response assessment
  • Exposure assessment
  • Risk characterization

Risk Assessment

Ecological Risk Assessment

Difficult to assess because effect occur at wide range of scales
  • Individual plants and animals
  • Ecological communities over wide regions

Human-induced environmental stressors also range greatly
  • Good to bad
  • Acceptable to unacceptable

There is a need to quantify risks to the environment
  
  Case Study on Ecological Risk Assessment
    • Results in decrease in fish, algal blooms

Ecol. Risk Assessment
  • Used to help government and locals set priorities to manage and protect ecosystem