Pesticides
Very special chemicals!
Preserve safe uses!
You make a difference—know your stuff!
We live in a chemical world!

More than 32,000,000 known

- **Origin**
  - Natural and Synthetic
- **Class**
  - Organic and Inorganic
- **Use**
  - Process • • *Commercial Products* • • Pollutants

Foods • Drugs • Cosmetics • Pesticides
2500 BC  Pesticides to protect crops
Sulfur dusting in Sumeria about 4,500 years ago

15th century  some use of arsenic, mercury
and lead to kill pests

17th century  nicotine from tobacco leaves for use
as an insecticide

19th century  pyrethrum from chrysanthemums
and rotenone from derris root
## Early History of Pesticide Use in U. S. Agriculture

<table>
<thead>
<tr>
<th>Year</th>
<th>Pesticide</th>
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<th>Year</th>
<th>Pesticide</th>
</tr>
</thead>
<tbody>
<tr>
<td>1865</td>
<td>Paris green copper acetoarsenite paint pigment Colorado potato beetle</td>
<td>1892</td>
<td>lead arsenate gypsy moth forest and shade trees</td>
<td>1910</td>
<td>arsenicals nicotine pyrethrum derris (rotenone) lime-sulfur (Bordeaux mixture)</td>
</tr>
<tr>
<td>1942: $4 \times 10^6$</td>
<td></td>
<td>1945: $80 \times 10^6$</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Discovery and use of DDT as an insecticide 1942 to 1972 (U.S.)
Pesticide. Any substance which alone, in chemical combination, or in any formulation with one or more substances is defined as a pesticide in section 2(u) of the Federal Insecticide, Fungicide, and Rodenticide Act (7 U.S.C. 136(u) et seq).
Toxicology

Scientific study of adverse effects of chemicals

- **Effects** are determined by dose

- Principle codified by a physician, alchemist, philosopher: Paracelsus, 1450

- *If dose determines a poison, there must be a safe level of everything!*
The label helps you get maximum benefit at minimum risk.

Safe use instructions

Signal word
Six Pack: Basic Acute Toxicity Testing

- Lethal oral dosage
- Lethal skin dosage
- Lethal inhalation dosage

- Eye irritation
- Skin irritation
- Sensitization (allergy)
What about other possible effects of chemicals?

Cancer
Birth defects
Reproduction
Growth and development
Hormonal responses
Behavior
√Disease clusters
Safety Evaluation: Exposure-Response Relationships

- RfD
- "No Effect" NOAEL
- Lethal
- Active or "Side-Effect"
- ED50
- LD50

DOSE
Regulation: How much is too much? How little is OK?

- LD50
  - ED50
    - Threshold or Low Observed Adverse Effect Level
      - No Observed Adverse Effect Level
        » No Observed Effect Level
    Uncertainty factors
      - Species 1/10
      - Intraspecies 1/10
      - Special (children) 1/10

  o Reference Dose (mg/kg-day)
Risk Assessment
Finding the amounts of exposure that do nothing to health (and environmental quality)!

1. Hazard Identification (what?)
2. Dose-response (time/amount)
3. Exposure assessment (animal→human)
4. Risk characterization → Regulation
Take this, try that!

Rats and Mice have had a rough 50 years!
Pesticides are top food-related health concern

Trace chemical residues became a public concern in the 1960s
“...to be on the safe side, she doesn’t buy.”
“Pesticide residues are a condition of production…”

Harvey Wiley, founder FDA 1906

Lead arsenate residues, ca. 1900
Causes of Foodborne Illness

- Amnesic Shellfish Poisoning and Domoic Acid
- Campylobacter jejuni
- Ciguatera Poisoning
- Clostridium botulinum
- Clostridium perfringens
- Cyclospora cayetanensis
- Hemolytic Uremic Syndrome (E. coli 0157:H7)
- Listeria monocytogenes
- Paralytic Shellfish Poisoning
- Red Tide, PSP and Safe Shellfish Harvesting
- Salmonella
- Scombroid Poisoning
- Shigella
- Toxoplasma gondii

Public health experts estimate that there are 11 to 13 million cases of foodborne illness in Canada every year. Many more in the USA...

“How many are caused by pesticide residues?”  Silence
If apples and pears looked like that, and foodborne sicken and kill, why are pesticides perceived as such a threat to health in developed countries of the world?
Food Purity
A BASIC HUMAN CONCERN

Food as Food
Properties
Ingredients
Chemicals
Organic food is produced **without**

1. **most conventional pesticides**
2. fertilizers from synthetic ingredients or sewage sludge
3. bioengineering
4. ionizing radiation.

USDA Consumer Brochure: *Organic Food Standards and Labels: The Facts*
“Organic agriculture practices cannot ensure that products are completely free of residues; however, methods are used to minimize pollution from air, soil and water.

USDA National Organic Standards Board (NOSB) definition, April 1995
The public revulsion for pesticides is magnified by the thought they will become part of us.

B. Krieger, 2008
People choose to avoid pesticide exposure—is there a measurable benefit?

Pests live their lives for free on field crops!

Crops are grown to sell; not to give away!

Pesticides are purchased to protect crops for sale—5-A-Day is a healthy choice!

Consumers will have a residue exposure.
What about the pesticide exposure that the consumer wants to avoid…

**Residue to Dose**

<table>
<thead>
<tr>
<th>Residue level, ppm</th>
<th>Amount eaten, g</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>50 g strawberries</td>
</tr>
<tr>
<td></td>
<td>1 ppm insecticide</td>
</tr>
<tr>
<td></td>
<td>50 g x 1 ug/g = 50 ug</td>
</tr>
</tbody>
</table>

- Dosage is amount per body weight
  - 50 ug/100 kg or
  - 0.5 ug/kg

*If 2 tablets acetaminophen*
- 6,500 ug/kg

*Pesticide residues are tiny!*
But this is about residues!

- Residue, 1 ppm
- No Effect Level 5 mg/kg

- How much at one meal?
\[
\frac{5 \text{ mg/kg}}{0.5 \text{ ug/kg}} = 10,000 \text{ servings!}
\]

- More than 100 full 8 pound trays to get to “No Effect” Level

But don’t worry....

Vitamin C diarrhea
Methanol blindness
Ethanol drunkeness
Will protect you from the NOAEL pesticide!
## Do misconceptions about food safety hurt your business?

<table>
<thead>
<tr>
<th>• Too small to matter</th>
<th>• Ignorance is the only excuse for poor decisions; it should be a very short-term condition</th>
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<td>• Opposition is beyond reason—not really</td>
<td>• Pervasive anxiety is an unhealthy state of mind</td>
</tr>
<tr>
<td>• Green must be good!</td>
<td>• Can obscure the public good, waste time and valuable resources</td>
</tr>
<tr>
<td>• Fear drives emotional decision-making</td>
<td>• Pragmatic decisions are no substitute for sound judgment and action</td>
</tr>
<tr>
<td>• Appeasement politics quiets the masses (for the short term)</td>
<td></td>
</tr>
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Your Experience and Public and Regulatory Perceptions of Pesticide Safety and Risk, 2008

Simply don’t match!
Chemicals, including pesticides, are not associated with risk unless they cause a harmful response in a vulnerable group of exposed people.

1. Chemical
2. Exposure
3. Harm
Regain public confidence in pest control by responsibly reversing food safety fallacies!

Bob Krieger
PCEP, UCR 2008