Pesticides
A Bit of Pesticide History

Before W.W.II pesticides in common use throughout the US were predominantly inorganic materials, such as sulfur, lead, copper, arsenic, boron, mercury, as well as botanical compounds such as nicotine, pyrethrum and rotenone.
World War II Created a New Generation of Pesticides

During this time DDT insecticide was developed by the Swiss, changed the nature of pest control worldwide.

The extraordinary effectiveness of DDT and the related materials that followed it; Lindane, dieldrin, chlordane, 2,4-D, all slowed or stopped research and development of other, less toxic methods of pest control.
850 pesticides in production.
215 fungicides/nematicides.
1200 Active Ingredients.
200 major pesticides.
230 disinfectants.
365 insecticides.
90 rodenticides.
Pesticide Use: 1990

- 2.5 million tons worldwide
- 888 million pounds used in the US. EPA
- 500,000 tons of 600 different pesticides at cost of $4.1 billion ~ 4.5 lbs / person
- 130 US firms make 37,000 products
- 10x increase in insecticides between 1945-1989
  Pimentel, et.al '93
- Annual U. S. pesticide user expenditures totaled approximately $11,090 million in 2001 accounting for about 34% of the total world market. EPA
Pesticide use:

More than 78 million households in the United States used a pesticide or herbicide.

Herbicides were the leading type of pesticides.

85 to 90 million pounds of the herbicide glyphosate was used in 2001.

2,4-D was the most widely used pesticide in both the home and garden, 8 million pounds used/yr.

http://www.epa.gov/oppfead1
Pesticide use

A bar chart showing the use of different types of pesticides in millions of dollars:
- **Herbicides**: $7,000 (Agriculture), $2,000 (Industry/Commercial/Government), $1,000 (Home & Garden)
- **Insecticides**: $3,000 (Agriculture), $1,000 (Industry/Commercial/Government), $500 (Home & Garden)
- **Fungicides**: $1,000 (Agriculture), $500 (Industry/Commercial/Government), $200 (Home & Garden)
- **Other**: $500 (Agriculture), $200 (Industry/Commercial/Government), $100 (Home & Garden)
Why so Many Pesticides?

- ~ 6 billion mouths to feed, & plants feed the world. Fewer producers to feed more people.
- 80,000 to 100,000 diseases.
- 30,000 competing weeds (1800 --> loss).
- 3,000 sp. Nematodes.
- 1 million sp. insects (10,000 plant feeders).
Why so Many pesticides?

- 33+% world's food crops lost to pests.
- Increased urbanization.
- Insect-borne diseases --> millions killed or disabled.
- Annual losses due to pests ~ $100 billion.
- In Ghana, application of insecticides to control one insect increased cocoa production by 3x.
- One estimate is 12% increase in crop loss if all pesticides banned.
- $1 spent --> $4 saved.
Why so Many Pesticides?

Thresholds

- Broccoli: 60 aphids/thrips/mites per 100g
- Spinach: 50 aphids & 8 leaf miners per 100g
- Berries: 4 larvae per 500 g
- Tomatoes (paste & sauce): 30 fly eggs, or 15 fly eggs & 1 maggot, or 2 maggots per 100 g
- Peanut butter: avg. of 30 insect fragments/100g
Definitions

Pesticides are substances or mixtures intended for controlling, preventing, destroying, repelling or mitigating any form of life declared to be a pest.
Active Ingredient

- The Active ingredient (actual pesticide chemical) may require mixing with one or more chemicals in order to make it satisfactory for use.

- Active pesticide chemicals are frequently in a form, which is not suitable for direct application.
Synergism

- Occurs between two or more chemicals when their combined exposure causes more adverse effects than the sum of their individual effects.
- “other ingredients”.
Synergism:

This occurs when one compound enhances the effect of another many times beyond what would be experienced if either were encounter alone. (Like alcohol and drugs).

Constant exposure to various pesticides throughout out the day.
Synergism

- Synergists are usually combined with insecticides in ratios from 2:1 to 10:1 (synergist to insecticide).

- In the presence of a synergist, a little active ingredient can go a long way.
Synergism-
Piperonyl Butoxide

- Piperonyl butoxide, which is derived from sesame, is the most common synergist.
- Piperonyl butoxide is a registered pesticide.
- It is used in most products containing pyrethrins.
- Also formulated with rotenone, ryania, sabadilla, citrus-oil derivatives and some synthetic pyrethroids.
Piperonyl butoxide

- It is somewhat controversial because there are indications that chronic levels of human exposure to this can affect the nervous system.
- *Not allowed* for use in certified organic productions.
Inert Ingredients

- Most pesticide products contain “Inert Ingredients”
- Very limited information on Inert Ingredients
- Manufacturers consider them a trade secret.
Inert Ingredients

- **Xylenes**, found in agricultural insecticides. Cause eye, skin irritation, headaches, nausea, confusion, tremors and anxiety.

- **Methyl paraben**, found in head lice products. Regulated as a drug, causes skin sensitivity, digestive and respiratory irritation.
Inert Ingredients

- **Dimethyl ether**, found in flea products, causes respiratory, skin and eye irritation, depresses the central nervous system.

- **Butane**, found in household insecticides, exposure causes irritation, nausea and drowsiness.
Sub-classed into groups by types of Pesticides:

- **Acaricide**: mites, ticks
- **Algaecide**: algae
- **Attractant**: insects, birds
- **Avicide**: birds
- **Bactericide**: bacteria
- **Defoliant**: unwanted plant leaf
- **Desiccant**: plants requiring dehydration
- **Fungicide**: fungi
Sub-classes of pesticides

- Growth Regulators - insects and plants
- Herbicide - weeds
- Insecticides - insects
- Miticide - mites
- Molluscsides - snails, slugs
- Nematicide - nematodes
- Piscicide - fish
- Predacide - vertebrates
- Rodenticides - rodents
- Silvicide - woody vegetation
Classified by Function

- **Attractants**, compounds that attract pest to traps or Poison, including sex based and food based.
- **Repellents**, compounds that repel the target pest
- **Desiccants**, compound that kill by adhering to insect cuticle, abrading a hole and drying out the insect, (i.e) diatomaceous earth, silica aerogel.
Classified by Function cont...

- **Growth Regulators**, compounds that mimic insect hormones that regulate development.
- **Contact Poisons**, penetrate the skin, disrupts the physiology of the organism.
- **Stomach poisons**, attack after it has been ingested. Bacillus thuringiensis (BT) and boric acid.
Classified by Formulation

**Wettable Powder**, are finely ground, dry powders.

The wettable powders are intended for dispersion or suspension in a liquid, usually water for application by spray.

Used on fruits, veggies, and various crops.
Classified by Formulation

- **Soluble Powder:** formulation ingredients will completely dissolve in water.
- **Dusts:** Finely ground carrier material containing the active ingredient. Intended for direct application without further mixing. Use, spot treatment and small areas of home gardens, sulfur on grapes.
Classified by Formulation

- **Fumigants.** Volatile chemicals, which become liquid when stored under pressure.
- Used in confined spaces.
- When applied they form a gas, which will destroy pest organism.
- Used in stored grain and soil treatment.
Classified by Formulation

- **Baits.** Active ingredients are mixed with a pest food or attractant. Use ants, mice, rats,

- **Aerosols.** Pressurized cans which a small amount of pesticide that is driven through a small nozzle under pressure from an inert gas. Use, fly control

- **Flowables.** Liquid usually mixed with water in a sprayer. Forms a suspension in water with require continual agitation. Use similar to wettable power
Classified by Formulation

- **Water soluble concentrate.** Liquid formulations form true solutions in water and require no agitation once mixed.

- **Encapsulated Material.** Active ingredient is encased in an inert material for a slow sustained pesticidal release. Pen-cap-M.
Classified by **Function**

- **Pass through**, livestock is feed this passes through in the manure where a target pest eats it. Flies.

- **Systemics**, absorbed by the plant or animal, kills any organism that feeds on that tissue. Horse wormers.

- **Sterilants**, used in soils that kill all life in the soil, methyl bromide. Potatoes.
3 main attack modes

Ways Pesticides Attack Pests

Contact Poison
Stomach Poison
Systemic Poison
Lethal Dose (LD 50)

The 50 in this expression refer to the dose of a given substance that kills 50% of the organisms exposed to it in the sites.

The LD 50 rating is usually expressed in milligrams of poison per kilogram of body weight. ex LD 50 rating of 1.0 mg/kg and each individual in a group of 150 lb. men consume approx. 6.8 mg of the pesticide, presumable half the individuals will die immediately.
Lethal Dose, Oral Toxicity

Oral Toxicity

Acute Oral LD50 Ratings as Compared to the Amount of Lethal Dose

<table>
<thead>
<tr>
<th>Acute oral LD50</th>
<th>Probable lethal dose, 150-pound adult</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>few drops</td>
</tr>
<tr>
<td>50</td>
<td>1 teaspoonful</td>
</tr>
<tr>
<td>500</td>
<td>2 tablespoonsful</td>
</tr>
<tr>
<td>1,500</td>
<td>1 pound</td>
</tr>
<tr>
<td>5,000</td>
<td>2 pounds</td>
</tr>
</tbody>
</table>

Vocational Agriculture Service - College of Agriculture - University of Illinois at Urbana-Champaign
(Safe Use of Pesticides 23)
Lethal Dose (LD 50)

- The higher the rating the less acutely poisonous.
- Bleach has a LD of 150.

Laundry Bleach, Very toxic, taste to teaspoon.

Rubber Cement, High toxicity, teaspoon to tablespoon.

Liquid Detergent, Moderate toxicity, ounce to a pint.

Baby Lotion, Low toxicity, pint to a quart.
Warning labels

(3) levels of alert or Categories concerning the amount of pesticide to kill a 150-pound person.

1 - Category I, **DANGER** (highly hazardous poison) taste to teaspoon.

2- Category II, **WARNING** (moderately hazardous) Teaspoon to a tablespoon.

3- Category III and IV, **CAUTION** (slightly hazardous to relatively non hazardous) Ounce to a pint.
Words on the Label

Signal Words

- **DANGER**
  - Highly Toxic

- **WARNING**
  - Moderately Toxic

- **CAUTION**
  - Slightly Toxic to Relatively Nontoxic
Pesticide Entry

Pesticides and the Human Body
Routes of Entry

Dermal Exposure  Oral Ingestion  Respiratory Exposure

Vocational Agriculture Service  College of Agriculture  University of Illinois at Urbana-Champaign
(Safe Use of Pesticides 22)
Absorption of Pesticides

Rates of Absorption of Pesticides into the Human Body
Pesticides are absorbed through different parts of the body at different rates. This illustration shows the relative rates of absorption for the insecticide parathion.

- Scalp
- Forehead
- Ear canal
- Behind ear
- Jaw
- Armpit
- Forearm
- Abdomen
- Top of hand
- Palm of hand
- Scrotum
- Ball of foot

(From Marer, 1988.)
Symptoms

- Pesticides affect humans and other mammals.
- Fatigue headache, dizziness, nausea, and mild physical distress to muscular weakness and breathing difficulty.
Symptoms

Mild Poisoning
Fatigue, Headache, Dizziness, Blurred vision, sweating, nausea, stomach cramps.

Moderate Poisoning
Unable to walk, weakness, chest discomfort, constriction of pupil of eye.
Insecticidal modes of action

- Nerve poisons
- Muscle poisons
- Physical toxicants
- Repellants
Neurons: are elongated cells that carry sensory information (sensory neurons).

or they carry information to stimulate muscles and glands (motor neurons).

May also connect sensory and motor neurons with the central nervous system.
Nerve Cell- Biology

The Axon is part of a neuron that transmits information or nerve impulses to other cells.

Synapses are connections between nerve cells.

Acetylcholine is primary neurotransmitter in insects.

Acetylcholinesterase (an enzyme) who’s role is the termination of impulse transmissions so the next nerve impulse can be transmitted across the synaptic gap.
Cholinesterase enzymes

Cholinesterase acts as a scavenging enzyme in the detoxification of natural compounds.

Cholinesterase is required for normal nervous function.

Impulses proceed from one nerve to another, or from a nerve cell to an organ or gland.
Nerve Poisons

- **Synaptic poisons** - act by interrupting normal synaptic transmission of nervous system. Causing the nerve to continue to fire causing tremors and death.

- **Axonic poisons** - interrupt normal axonic transmission of nervous system. (Pyrethroids and chlorinated hydrocarbons).
Nerve Poisons

- **Anti-cholinesterases** - organophosphates and carbamates.
- **Cholinomimetics** - nicotine and nicotine sulfates.
Physical Toxicants

- Block metabolic process via physical rather than chemical means.
- Oils are used against aquatic pests to prevent respiration.
- Dormant oils work against scale insects by clogging spiracles.
Repellants

- Does not kill insects.
- Very low toxicity to no toxicity.
- LD 50 levels of 1,800 to 2,700.
Repellants “Deet”

- Developed by scientists at the U.S.D.A.
- Patented by the U.S. Army in 1946.
- Registered for use by the general public in 1957.
- A broad-spectrum repellent effective against mosquitoes, biting flies, chiggers, fleas, and ticks.
Repellants - Deet

- *N,N*-diethyl-3-methylbenzamide (DEET)

The most effective, and best studied, insect repellent currently on the market.

This substance has a remarkable safety profile after 40+ years of worldwide use, but toxic reactions can occur (usually when the product is misused).
Insect Growth Regulators

- Juvenile hormones (disrupt immature development & adult emergence).
- Precocenes: interfere with glands which produce juvenile hormones.
- Chitin synthesis inhibitors (Dimilin® = diflubenzuron) Persistent by today's standards. Nontoxic to mammals Affect most organisms that molt.
- Not systemic.
Insect Growth Regulators

- Precocenes: interfere with glands which produce juvenile hormones.
- Chitin synthesis inhibitors.
- Persistent by today's standards.
- Nontoxic to mammals.
- Affect most organisms that molt, not systemic.
Two Main Chemical Groups: Inorganic and Carbon Based.

**In-organic pesticides**: Stable & water-soluble.

- Boric acid, borates, chlorates, copper sulfate, diatomaceous earth, silica aerogel, Stomach poisons.
- Sodium Hypochlorite (bleach) chemically burns the pest, oxidizing the tissue.
Carbon Based (C)

... compounds which sometimes also contains hydrogen, oxygen, nitrogen, phosphorous or sulfur, with majority of all modern pesticides, insoluble in water.
Types of Carbon based Pesticides

Organochlorines
Organophosphates
Carbamates
Chlorinated hydrocarbons
Organochlorine Characteristics

- Nerve poison, affects sodium and potassium balance; aldrin, dieldrin, toxaphene (soil insecticides) DDT.

- DDT was very successful in WW II against body lice, fleas vectoring typhus, and malaria-carrying mosquitoes.

- After the war it was found to be effective against a wide range of agricultural pests. Because of its ridiculously low cost it was overused and abused.
Organochlorine Characteristics

Persistent, UV resistant.
Low solubility in water.
High lipid (fat) solubility -> biomagnification.
Still produced and sold in many developing countries.
Chlorinated hydrocarbons

- Chlordane
- Lindane
- Aldrin

- No longer on the U.S. Market.
- Still tested for.
Organophosphate

By-product of nerve gas and chemical warfare research in WWII in Germany.

Diazion, Malathion, Orthene, Penncap-M.

They inactivate the cholinesterase enzymes. Synaptic or Nerve poison.

Used as agricultural insecticides.
Organophosphates

- More toxic to mammals than Organochlorines.
- Many are systemic.
- For 75% of Malathion to break down it takes 1 year.
- Diazion is highly toxic to birds, and very toxic to aquatic species. Non-persistent.
Carbamates *(Sevin, baygon)*

- Carbaryl and carbofuran pesticides.
- Carbamates inactivate the cholinesterase enzymes.
Chlorpyrifos

Over the counter sales of Chlorpyrifos were halted December 1, 2001. epa

Dursban

Found in many lawn and garden products.
Chloronicotinyls

- Synthetic version of nicotine, disrupts the nervous system.
- Broad spectrum, long residual, low rate (a little goes a long way) and systemic.
Pyrethrum
Pyrethrin
Pyrethroid
Permethrin
**Pyrethrum** and its derivatives

- Refers to the dried, powdered flower heads of the plant; *Pyrethrum roseum* = *Chrysanthemum coccineum*.
- One of the most important insecticide ever developed.
- Probably, China was the first source of pyrethrum.
- Persist only a few hours.
Pyrethrin

- Refers to the active ingredient compounds that occur in the flowers.
- Disruption of normal transmission of nerve impulses, causing virtually instant paralysis in insects.
- Some insects can detoxify Pyrethrin and recover from the initial knockdown so most pyrethrins are combined with a synergist, which blocks the insects ability to break down the toxin.
**Pyrethroids**

- Synthetic compounds that resemble pyrethrins in chemical structure but are more toxic to insects.
- May last 10 days or more compared to a few hours for the natural botanicals.
- *(permethrin)* vary in formulation and use. Skin problems.
- **Very toxic to fish** 0.15 parts per billion will kill 50% of fish it comes in contact with.
Permethrin

- Synthetic Pyrethroid family.
- Used on cotton (60%), wheat, corn, alfalfa, home use.
- Can persist up to 3 days.

Coalition for alternatives to pesticides, Eugene, or., journal of pesticide reform/summer 1998 vol 18. No 2141
Permethrin

- Acts as a Neurotoxin.
- Rather than sending a single impulse in response to a stimulus, permethrin expose nerves send a train of impulses.
- Symptoms: tremors, in-coordination, elevated body temperature.
- In kids; increased aggressive behavior, and disruption to learning.
Permethrin

- Toxic to honey bees and other beneficial insects such as; Mayflies, Damselflies, it is highly toxic to fish and aquatic insects.
- A wide variety of insects have developed resistance to permethrin such as; cockroaches, head lice and tobacco budworm.
Permethrin

- Has been found in streams and rivers throughout the U.S.
- It has been found on spinach, tomatoes, celery, lettuce and peaches.
- It is the 13th most commonly detected pesticide on produce.
Deltamethrin is a Pyrethroid insecticide.

- Death of insects seems to be due to irreversible damage to the nervous system occurring when poisoning lasts more than a few hours via contact and through digestion.

- Used in household insect pesticides. It also controls numerous insect pests of field crops.

- Synthetic insecticide based structurally on natural pyrethrins.
Deltamethrin

Has very broad spectrum control. It is considered the most powerful of the synthetic pyrethroids. It is up to three orders more active than some pyrethroids.

EXTOXNET

Extension Toxicology Network

Pesticide Information Profiles
Imidacloprid

- Systemic, chloro-nicotinyl insecticide.
- Soil, seed and foliar uses for the control of sucking insects including leaf hoppers, aphids, thrips, whiteflies, termites, turf insects, soil insects and some beetles.
Imidacloprid

- The chemical works by interfering with the transmission of stimuli in the insect nervous system.
- Specifically, it causes a blockage in a type of neuronal pathway (nicotinergic) that is more abundant in insects than in warm-blooded animals (making the chemical selectively more toxic to insects than warm-blooded animals).
- It is effective on contact and via stomach action.
- However: ............
Methyl Anthranilate
Gives off the “foxy” aroma in wine, is used in a wide variety of fragrances and flavors.
It is best known for giving grape Kool-Aid its aroma and taste. Source is from Grapes.

Approved as the only licensed repellent to use against Canada geese.
Herbicides

- Amino Acid Synthesis Inhibitors
- Cell Membrane Distruptors
- Growth Regulators
- Lipid Synthesis Inhibitors
- Photosynthetic Inhibitors
- Seedling Growth Inhibitors
- Unclassified
Amino Acid Inhibitors

Amino acid synthesis inhibitors act on a specific enzyme to prevent the production of specific amino acids, the key building blocks for normal plant growth and development.

- Injury symptoms are: slow to develop (1 to 2 weeks), stunting or delayed plant growth that leads to eventual death of the plant.

- Can move in both the xylem and phloem to areas of new growth and can be taken up through plant foliage and roots.

- The amino acid derivative herbicides are nonselective.
Glyphosate

(Roundup Ultra)

**Injury Symptoms:** Youngest leaves near the growing point slowly become chlorotic and later die.

Chlorotic segments may appear in heads after exposure to very low rates.
Glyphosate

- Glyphosate is strongly adsorbed to soil, with little potential for leaching to ground water.
- Microbes in the soil readily and completely degrade it even under low temperature conditions.
- It tends to adhere to sediments when released to water.
- Glyphosate does not tend to accumulate in aquatic life.

- EPA
Cell Membrane Disruptors

Herbicides in this family are postemergence contact herbicides that are activated by sunlight to form active compounds that disrupt the plant cells causing disintegration of cell membranes and chloroplasts.

Destruction of cell membranes results first in rapid desiccation of plant foliage (wilting), followed by necrosis, and eventual death of the plant.

On bright sunny days herbicide injury symptoms can occur in one to two hours.

are contact herbicides, they are an excellent choice for burn down of annual weeds.

Because of the limited translocation of this chemical within plants, underground root systems are not destroyed and perennial weeds usually regrow after their top growth has been destroyed.
Growth Regulators

- Interfere with numerous biological activities and protein synthesis of plants, causing a variety of plant growth abnormalities.
- Are selective against broadleaf weeds but are capable of injuring grass crops.
- Move systemically in the plant by way of the phloem or xylem.
- Are quickly translocated to areas of new plant growth making them very effective against annual and perennial broadleaf weeds.
- Herbicide uptake is primarily through the leaves but root uptake is also possible. Injury symptoms are most obvious on newly developing leaves. 2,4-D
Seedling Growth Inhibitors

- They are soil-applied herbicides.
- Interfere with development of seedlings as they emerge from the soil.
- Seedling growth inhibitors are active at two sites, the developing shoot and the root.
- Root-inhibiting herbicides stop plant cell division, which in turn inhibits shoot elongation and lateral root formation.
- Translocation of the herbicide is limited within the plant.
- Shoot-inhibiting herbicides are absorbed by developing shoots and roots and are transported via the xylem and phloem to areas of new growth.
Atrazine

(2-chloro-4-ethylamino-6-isopropylamino-s-triazine).

One of the most widely used herbicides for broadleaf weed control.

40 million kg applied annually in the USA.

Relatively high application rates (up to 5 kg ha⁻¹) lead to concentrations in soil up to 5 mg kg⁻¹.

Well water in some agriculture communities may contain up to 70 mg L⁻¹.

Persistent in soil with a half life of 300+ days.
What If……

Rocky Mountain Poison Center
800-332-3076

National Pesticide Information Center
800-858-7378
Pesticide Persistence

All pesticides break down chemically into other related chemicals and eventually into hydrogen, carbon and oxygen. This process occurs at very different rates for different pesticides.
Pesticide Persistence

Short Lived pesticides: Some break down in hours or a few days
Pesticide Persistence

Long lived or persistent pesticides, determined by: conditions of temperature, sunlight, air and location.

Problem: once released into the ecosystem they remain in the original chemical form long enough so that if they have the other properties of moving readily and of being stored in animal tissues, they can spread to a distance and be concentrated at some other place than where they were applied.
Pesticide Persistence

Accumulation: they can accumulate in the food chain some pesticides can build up in the body of animals, be transported from animal to man, indirect poisoning.
Non-accumulative Pesticides

- Some pesticides do not build up in the body of animals or in the food chain, these chemicals usually break down rapidly into other relatively harmless materials.
- Organophosphate pesticides, are high toxicity at first, do not accumulated, and they are not as dangerous to the environment in general.
- Usually pesticides that breakdown quickly is less harmful in the environment.
Residues

When pesticides sprays fall on non-target areas, clothing, tools, equipment, and mix with the air.
Resurgence

When the predators, parasitoids or pathogens that would naturally control the pest are temporarily removed or drastically reduced in numbers.
Resurgence

Spraying aphids you may kill predators such as lacewings or ladybugs. It is quite possible to decimated the natural enemies or reduce the number below adequate numbers to control the aphids.

The remaining aphids multiply with fewer restraints, the problem can even worsen.
Resistance

Some of the pests that survive to produce the next generation develop a means of avoiding or detoxifying the poison.

On subsequent exposure the bug is far less or not at all susceptible to the poison.
Biomagnification

The application of most pesticides result in only a small amount of the poison actually reaching the target pest. Most of material lands in adjacent areas.

Small amounts of poison distributed over plants or plant eating animals can become concentrated in the bodies of the organisms that eat those plants or animals.
Biomagnification

Earthworms may eat many fallen leaves; the pesticide is concentrated in the earthworm's body because of the number of leaves it consumes. This worm is then eaten by a bird, which may have eaten many such worms.
Biomagnification

A predator such as a hawk may eat that bird, at that time there may be a high enough concentration of poison that that animal may become sick or suffer an impaired ability to reproduce.
People Problems

Neuro-degenerative diseases such as Parkinson’s Disease and Alzheimer’s Disease have been linked to toxic chemical exposure.

U.S. Congress, Neurotoxicity: identifying and Controlling Poisons of the nervous System.
People Problems

- Only 2% of the doctors in the U.S. are qualified to diagnose chemical poisoning and its related problems. (Institute of Medicine, Division of Health promotion and Disease Prevention).

- Exposure to neurotoxins is one of the top ten causes of illness and injury in the U.S. work force. (U.S. Congress, 99th Congress, 2nd Session)
People Problems

There are: 183 chemicals that cause convulsions, 62 that cause paralysis, 177 that cause tremors, 179 that cause weakness, 135 that cause equilibrium changes, 121 that cause vision disorders, ……These chemicals are found in such common things as rubber cement, paint, photography chemicals, grout, cleaning products, adhesives and textiles (U.S. Dept of Health and Human Services)
Banned Insecticides

- Diazion
- Dursban
- Orthene
- Cygon
- Kelthane
Bio-Rational Insecticides

- Specific to that insect or more selective to that pest.
- Non-target insects or animals are not affected at all or very little.
Bio-Rational Insecticides

- Include naturally occurring substances that control pests (biochemical pesticides).
- Microorganisms that control pests (microbial pesticides).
- Pesticidal substances produced by plants containing added genetic material (Plant-Incorporated Protectants) PIPs, (Bt. Corn).
Microbials

Biological Insecticides

- Diseases formulated as sprays.
- Nontoxic to mammals,
- Not systemic. Must be consumed by insect (e.g., caterpillars).
- Various fungi Nonpersistent (very short).
- Bacillus thuringiensis.
- Nosema Locustae a type of protozoa, for grasshopper control.
- Nucleopolyhedrosis virus (NPV)
Nucleopolyhedrosis virus (NPV)

- Considerable research to develop the gypsy moth NPV as a biological pesticide.
- Infection occurs when caterpillars eat foliage contaminated with viral occlusion bodies.
- This pathogen invades through the gut wall, reproducing rapidly, causing the disintegration of internal organs and the death of the host caterpillar.
- Eventually, the host ruptures, distributing viral occlusion bodies into the environment which serve to infect other individuals.
Kaolin Clay

Spray was developed by Drs. Michael Glenn and Gary Puterka of the USDA/ARS at Kearneysville, WV.

A non-toxic particle film that places a barrier between the pest and its host plant.

Sprayed on as a liquid, which evaporates, leaving a protective powdery film on the surfaces of leaves, stems, and fruit.
Kaolin Clay

- Tiny particles of the clay attach to the insects when they contact the tree, agitating and repelling them.

- Even if particles don’t attach to their bodies, the insects find the coated plant or fruit unsuitable for feeding and egg-laying.

- The active ingredient is kaolin clay, an edible mineral long used as an anti-caking agent in processed foods, and in such products as toothpaste and Kaopectate.
Kaolin Clay

Control: leafrollers, leafhoppers.

Suppression: mites, codling moth, thrips plum curculio, stink bugs, apple maggot.

Horticultural Benefits: reduced heat stress and fruit drop, reduced sunburn, improved color in certain cultivars.

SurroundWP™
NEEM (Azadirachta indica)

- Grown as a shade tree in Africa, Subtropical regions of U.S.
- Has been used as medicinal preparations and pest control products for centuries.

- Principal active ingredient is azadirachtin, more then 25 other active compounds have been isolated.
NEEM (Azadirachta indica)

- Modes of action.
- Its various active ingredients act as: repellents, feeding inhibitors, egg-laying deterrents, growth retardants, sterilants and direct toxins.
- These multiple modes of action make it unlikely that insects or pathogens will develop resistance.
NEEM (Azadirachta indica)

**Plants**
- Both as a contact and systemic action in plants. Can be applied to the soil, most roots should absorb it.
- New growth on a plant must be re-sprayed for neem oil to be effective.
NEEM (Azadirachta indica)

- Neem-oil extracts show very low toxicity to mammals. The LD-50 is greater than 13,000.
- The active ingredient biodegrade rapidly in sunlight and within a few weeks in the soil.
- Preliminary studies also indicate that certain beneficial insects such as hymenoptera parasitoids and predatory mites escape the effects of Neem.
NEEM (Azadirachta indica)

- Extracts have inhibited feeding in 170 insect species in seven (7) orders.
- Have inhibited normal growth in species in four (4) orders.
- Proven to be directly toxic to aphids, termites and various caterpillars.
Spinosad

- Is a soil-dwelling bacterium called *Saccharopolyspora spinosa*.
- Spinosad poses less risk than most insecticides to mammals, birds, fish, and beneficial insects.
- A unique mode of action coupled with a high degree of activity on targeted pests and low toxicity to non-target organisms (including many beneficial arthropods).

"Spinosad Battles Crop Pests" was published in the April 2000 issue of *Agricultural Research* magazine.
**Spinosad**

- The mode of action: excitation of the insect nervous system, leading to involuntary muscle contractions, prostration with tremors, characterized by cessation of feeding and paralysis of exposed insects within minutes.

- No other class of products affects the insect nervous system with the same mode of action and no cross resistance to Spinosad has been demonstrated.
Spinosad

- It does not pose a threat to groundwater when used properly.
- Bio-degradable, primarily photodegradation and microbial degradation.
- The half-life of Spinosad degraded by soil photolysis is 9-10 days.
Sabadilla

- Botanical: *Veratrum sabadilla*, member of the lily family.
- Sabadilla contains several alkaloids, most toxic are found in the seeds.
- Breaks down rapidly in sunlight and leaves no residue.
Sabadilla

- Contact and stomach poison.
- Large doses cause paralysis of the heart action and respiration.
- Very toxic to Honey Bees and humans.
Diatomaceous Earth or D.E.

- Is mined from the fossilized silica shell remains of unicellular or colonial algae of diatoms.
- It has both abrasive and sorptive qualities.
- **Mode of Action**: it absorbs the waxy layer on the surface of insect skins, causing the insect to desiccate.
- It also works abrasively to rupture insect cuticles, allowing fluids to leak out.
- DE is virtually nontoxic to mammals.
Diatomaceous Earth or D.E

Use: as a border around vegetable and ornamental plants, sprinkled on carpets, pets, plants as a contact pesticide.

Used on: ants, bedbugs, bees, boxelder bugs, cockroaches, flour beetles, crickets, meal worms, fleas, grain mites, weevils, silverfish, spiders and ticks.
Garlic Oil

- Member of the lily family
- Modern studies have confirmed antibacterial, antifungal and Insecticidal qualities.
- As an insecticide spray it will also kill the beneficial insects. To be used where natural controls are not present.
Garlic Oil

1/8 pound of garlic (1 bulb)
1 quart of water
Blend in a mixer for 5 minutes
Dilute to one gallon

- Spray on plants or directly on insects, can use as a soil drench.

° Works best: to help control, repel and suppress mosquitoes, aphids, caterpillars, whiteflies, mites some beetles.

° The smellier the garlic the better.
Boron, Boric acid or Borax

- Work as a stomach poison when ingested, by disrupting the action of protozoa or bacteria in the insect’s gut, inhibiting the functioning of the enzymes that break down food.
- Can be used as a fungicides on molds, too much can become a herbicide.
- Too much will kill plants.
Boron, Boric acid or Borax

- Slow to work 5 to 10 days
- LD 3,200
- Apply as a thin film, insects pick this up on their legs, groom themselves, ingest it.

- 1-2 % solution
  - 1 Teaspoon boric acid
  - 1 Cup of warm water
  - 2 Tablespoons of sugar or honey
  - Pour around the ant hill.
Pesticidal Soaps

Mode of action:

Detergent or fatty acid soaps: may dissolve the protective covering and dissolve into the membranes around its cells, resulting in dehydration and death.

Non-Detergent soaps: act as a suffocate.
Pesticidal Soaps

- To strong a solution and it becomes a herbicide.
- Can also work as a fungicide.
- Insects must be present for this to work.
- Do not spray when temps are about 90 degrees.
- Don’t spray stressed or wilted plants.
Pesticidal Soaps

- Works on soft body insects such as: aphids, mealybugs and whiteflies.
- Does not work on most beetles.
- Good for indoor use.
- 2-3 Tablespoons of soap
  - 1 Gallon of water
  - Mix well
  - Can add 2 cups of boiled and strained citrus peel for severe infestations of insects.
Bacterial Insecticides

- About 100 species of bacterial insecticides.
- They have a very narrow host range.
- Lack of toxic effect on nontarget species including humans and natural enemies.
- Commonly found in soil.
Bacterial Insecticides

Mode of action

- Stomach poison, must be eaten to be effective.
- Works by blocking the enzyme systems that protect the insect’s gut from its own digestive juices.
- Will kill the insect in a matter of hours.
Bacterial Insecticides, Types:

- **Milky spore disease** for Japanese beetle grubs. First use in 1948
- **Bacillus thuringiensis v. kurstaki** for worms found on trees & veggies.
- **Bt v. israelensis** for mosquito control, black flies and fungus gnats.
- **Bt v. san diego** for larvae of Colorado Potato beetle, elm leaf beetle.
Traps

Coated with a sticky substance usually with an attractant such as a pheromone

Good for whiteflies, fungus gnats, aphids, leafminer flies, thrips and apple maggot flies

- For apple maggots hang trap in early June and leave until harvest. One per tree.
**Miscellaneous**

- **Hort oils**, most are petroleum based some vegetable based mixtures w/trace amounts of nitrogen and sulfur. Suffocating and smothering.
- Pepper solutions.
- Tobacco.
- Citrus solutions.
Repellants from the Web

- Brewers Yeast and Garlic powder in pet's dinners is supposed to keep fleas away.
- One of the best insect repellents someone found (who is in the woods every day), is Vick's Vaporub.
- If you eat bananas, the mosquitoes like you, - something about the banana oil as your body processes it.
- Bounce Fabric Softener.
- Vitamin B-1.
When and how to apply

- Mix pesticides at the correct rate.
- Calibrate equipment carefully.
- Be sure that you hit the designated target.
- Spray after irrigation if possible.
- Spray under favorable weather condition to prevent drift.
When and how to apply

- Learn about the chemical you are using.
- Protect the good bugs.
- Air temp should be cool, mornings late day best time to spray.
- **Never** mix a Fertilizer with a pesticides.
When and how to apply

- Spot spray when possible.
- Avoid repeat spraying.
- **Only if there is indication of insects that need to be sprayed.**
What to Protect

**Soil.** Pesticides often become attracted to fine soil particles and when the surface soil erodes, the chemical is carried along with it.

Overdoses of pesticides, which remain for long periods in the soil, may even limit planting.

Can adversely effect the soil bacteria, micro organisms, worms and fungi.
What to Protect

**Water.** Pesticides may reach water by accident, from drift, over spray or run off (drainage system).

*Can kill aquatic life. Case from run off: plankton absorbed pesticides from contaminated waters through the microorganisms they fed upon. Small fish ate the plankton, and these were in turn fed upon by larger fish. The brown pelican, at the top of food chain suffered a serious population decline due to the effects of these accumulated poisons.*
What to Protect

Air. The movement of pesticides in the air cannot be controlled.
- May settle onto water, crops, livestock, trees, people etc.
- Provide adequate spacing or a buffer zone when applying near sensitive areas.
What to Protect

**Plants.** Can injure plants called Phytotoxicity, causes leaf drop, stunting, overgrowth, and discoloration, leaf curl, stem distortion
What to Protect

- Beneficial Insects.
- Lady Bugs and their larvae.
- Green Lacewings, eggs and larvae.
- Praying Mantids.
- Beneficial Nematodes.
- Trichogramma wasps.
- Encarsia formosa (Whitefly parasite).
- Diglyphus isaes for leafminer control.
- Minute Pirate Bugs.
Places to buy beneficial insects

Places to buy beneficial insects

Planet Natural, www.planetnatural.com
1.800.289.6656.

Whatever works, www.whateverworks.com
1.800.499.6757.

Gardens alive www.gardensalive.com
1.513.354.1482.

PESTICIDES

Call City of Cheyenne Sanitation Department

307.637.6440

They take hazardous household waste by appointment every Saturday
Happy Gardening