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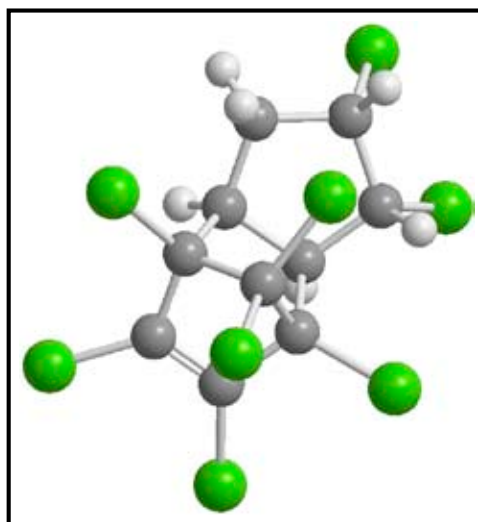
Some of the information in the following fact sheet (scroll down) is out-of-date. The National Pesticide Information Center (NPIC) is not currently planning to update this fact sheet. However, it remains available for historical purposes.

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### Molecular Structure - Chlordane



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NPTN Technical Fact Sheets are designed to provide information that is technical in nature for individuals with a scientific background or familiarity with the regulation of pesticides by the U.S. Environmental Protection Agency (US EPA). This document is intended to be helpful to professionals and to the general public for making decisions about pesticide use.

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# Chlordane

## (Technical Fact Sheet)

For less technical information please refer to the General Fact Sheet.

**The Pesticide Label:** Labels provide directions for the proper use of a pesticide product. *Be sure to read the entire label before using any product.* A signal word on each product label indicates the product's potential hazard.

**CAUTION** - low toxicity

**WARNING** - moderate toxicity

**DANGER** - high toxicity

## What is chlordane?

- Chlordane is an insecticide first registered in the United States in 1948 (1). In 1988, all uses of chlordane, except its use for fire ant control in power transformers, were voluntarily canceled in the United States (2).
- Chlordane was used on food and non-food agricultural crops, residential lawns and gardens, and against structural pests, particularly termites (2, 3).
- Chlordane is a chlorinated cyclodiene that is a mixture of closely related chemicals including chlordene, cis-chlordane, trans-chlordane, heptachlor, and nonachlor (2). Technical grade chlordane consists of over 50 compounds (4).
- Chlordane manufactured prior to 1950 was sometimes referred to as “early chlordane,” due to variable concentrations of the unreacted intermediate hexachlorocyclopentadiene. After 1951, the percentage of this intermediate was kept below 1%, resulting in lower toxicity (3).
- Technical chlordane is a thick clear to amber liquid. It may be odorless or exhibit a mildly irritating odor (2).
- Chlordane can still be legally manufactured in the United States, but it can only be sold to, or used by, foreign countries. Although chlordane can be used to control fire ants in the United States, no products are currently registered for this use (5, 6).

## Why were uses of chlordane canceled?

- Chlordane uses were canceled based on chlordane's potential carcinogenicity and persistence in the environment (2, 5). Several chemical properties that enabled chlordane to be effective against a wide variety of pests also led to its cancellation. For example, chlordane exhibits chemical stability, lipid solubility, low volatility, and a slow rate of biotransformation and biodegradation (7).

## What is chlordane's mechanism of action?

- Chlordane mimics the action of the nerve excitant picrotoxin. Picrotoxin and chlordane both serve as an antagonist of the neurotransmitter  $\gamma$ -aminobutyric acid (GABA) found in the central nervous system (CNS). GABA inhibition results in partial repolarization of the neuron and a state of uncontrolled excitation (7).
- Chlordane inhibits  $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$ -ATPase, an enzyme that is essential in transporting calcium across membranes. Inhibition of this enzyme results in the accumulation of free calcium ions. Neurotransmitters are then released causing “continued” stimulation of adjacent neurons throughout the nervous system (7).
- Chlordane is an inhibitor of  $\text{Na}^+$ ,  $\text{K}^+$ -ATPase (7).

## How toxic is chlordane?

### Animals

- Chlordane is moderately toxic if ingested. The acute oral LD50 for rats ranges from 150 to 700 milligrams/kilogram (mg/kg) body weight (3). See boxes on **Laboratory Testing**, **Toxicity Category**, and **LD50/LC50**.
- Chlordane is moderately toxic via dermal exposure. The dermal LD50 in rats is 590-840 mg/kg (8). Chlordane is irritating to the skin and eyes (9).
- Chlordane ranges from very low to moderately toxic through inhalation exposure. The 4-hour inhalation LC50 for rats ranged from 0.56 milligrams/liter (mg/L) to >200 mg/L (10).

### Humans

- In humans, acute exposure to chlordane may result in the sudden onset of convulsions. Convulsions may also occur up to 48 hours following a high level exposure. Convulsions may or may not be preceded by headache, nausea, vomiting, incoordination, tremor, and mental confusion. Convulsions may reoccur periodically for the next several days (11).
- The Reference Dose (RfD) for chlordane is  $6 \times 10^{-5}$  mg/kg/day (12). The RfD is “an estimate of a daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime (13).”
- The Reference Concentration (RfC) for chlordane is  $7 \times 10^{-4}$  milligrams/meter<sup>3</sup> (mg/m<sup>3</sup>). The RfC is analogous to the RfD previously cited except that it is an estimate of a continuous inhalation exposure (13).

**Exposure:** Effects of chlordane on human health and the environment depend on how much chlordane is present and the length and frequency of exposure. Effects also depend on the health of a person and/or certain environmental factors.

**Laboratory Testing:** Before pesticides are registered by the U.S. EPA, they must undergo laboratory testing for short-term (acute) and long-term (chronic) health effects. Laboratory animals are purposely fed high enough doses to cause toxic effects. These tests help scientists judge how these chemicals might affect humans, domestic animals, and wildlife in cases of overexposure. When pesticide products are used according to the label directions, toxic effects are not likely to occur because the amount of pesticide that people and pets may be exposed to is low compared to the doses fed to laboratory animals.

**Toxicity Category (Signal Word) (14)**

	<b>High Toxicity (Danger)</b>	<b>Moderate Toxicity (Warning)</b>	<b>Low Toxicity (Caution)</b>	<b>Very Low Toxicity (Caution)</b>
<b>Oral LD50</b>	Less than 50 mg/kg	50 - 500 mg/kg	500 - 5000 mg/kg	Greater than 5000 mg/kg
<b>Dermal LD50</b>	Less than 200 mg/kg	200 - 2000 mg/kg	2000 - 5000 mg/kg	Greater than 5000 mg/kg
<b>Inhalation LC50</b>	Less than 0.05 mg/l	0.05 - 0.5 mg/l	0.5 - 2 mg/l	Greater than 2 mg/l
<b>Eye Effects</b>	Corrosive	Irritation persisting for 7 days	Irritation reversible within 7 days	Minimal effects gone within 24 hrs
<b>Skin Effects</b>	Corrosive	Severe irritation at 72 hours	Moderate irritation at 72 hours	Mild or slight irritation

**LD50/LC50:** A common measure of acute toxicity is the lethal dose (LD50) or lethal concentration (LC50) that causes death (resulting from a single or limited exposure) in 50 percent of the treated animals. LD50 is generally expressed as the dose in milligrams (mg) of chemical per kilogram (kg) of body weight. LC50 is often expressed as mg of chemical per volume (e.g., liter (L)) of medium (i.e., air or water) the organism is exposed to. Chemicals are considered highly toxic when the LD50/LC50 is small and practically non-toxic when the value is large. However, the LD50/LC50 does not reflect any effects from long-term exposure (i.e., cancer, birth defects, or reproductive toxicity) that may occur at levels below those that cause death.

## Is chlordane metabolized and eliminated from the body?

### Animals

- After multiple animal studies, researchers determined that following oral exposure, chlordane levels are initially highest in the kidneys and liver. Chlordane and its metabolites are then redistributed to fat. Excretion occurs through the bile due to the high lipophilicity of the metabolites. Excretion can also occur through lactation (2).
- Scientists orally administered single doses of chlordane to rats and noted that the chemical was well absorbed. It distributed throughout the animals and was almost completely eliminated (>90%), primarily in the feces, within 7 days. Scientists did detect chlordane residues in several tissues, primarily fat (13).
- In a 56-day feeding study in rats, researchers observed that the concentration of chlordane in fat was three-fold higher than the chlordane in feed, indicating that chlordane does bioaccumulate (13).
- Chlordane is biotransformed in rats via two pathways into various breakdown products, including trans-chlordane, 1,2-dichlorochlordene, oxychlordane, 1-hydroxy-2-chlorochlordene, 1-hydroxy-2-chloro-2,3-epoxychlordene, chlordene chlorohydrin, and 1,2-trans-dihydroxydihydrochlordene (3).

### Humans

- Chlordane and its metabolites have been detected in human samples of fat, blood, and milk (3, 13).

## Does chlordane cause reproductive or teratogenic effects?

### Animals

- Scientists fed male and female rats a diet containing 320 mg/kg of chlordane from weaning. Animals had reduced rates of mating and a reduced viable litter count. In addition, researchers noted an increase in the death rate of progeny prior to weaning (15).
- Scientists intraperitoneally injected mice with chlordane at 25 mg/kg once a week for 3 weeks. Fertility was reduced approximately 50% in female mice (16).

- When scientists treated rats by gavage (stomach tube) with 0, 20, 40 and 80 mg/kg/day during gestation, they observed no evidence of fetal toxicity (2).

### Humans

- Reproductive and teratogenic effects in humans are unlikely, based on estimated exposure levels (9).

## Is chlordane a carcinogen?

### Animals

- Multiple studies have shown that high, daily dietary exposure to chlordane is associated with the development of hepatocellular carcinomas in mice (2).

### Humans

- The U.S. EPA categorizes chlordane as a probable human carcinogen (group B2) (12). This means that chlordane has been shown to cause cancer in laboratory animals, but there is inadequate or no evidence that it may cause cancer in humans. See box on **Cancer**.

**Cancer:** The U.S. EPA has strict guidelines that require testing of pesticides for their potential to cause cancer. These studies involve feeding laboratory animals large *daily* doses of the pesticide over most of the lifetime of the animal. Based on these tests, and any other available information, EPA gives the pesticide a rating for its potential to cause cancer in humans. For example, if a pesticide does not cause cancer in animal tests at large doses, then the EPA considers it unlikely the pesticide will cause cancer in humans. Testing for cancer is not done on human subjects.

- Chlordane has been implicated in some cases of human cancer (17).

## What is the environmental fate and behavior of chlordane?

- Chlordane is persistent in the environment and bioaccumulates (1). It does not readily breakdown by hydrolysis, oxidation, or photolysis (4).
- The soil half-life for chlordane is estimated at 350 days but can range from 37 days to 3500 days, depending on environmental conditions (18). See the box on **Half-life**.
- Field tests show that chlordane is immobile or only slightly mobile in soil. Despite its low potential to move in soil, chlordane has been detected in groundwater (4).

**Half-life** is the time required for half of the compound to degrade.

**1 half-life = 50% degraded**  
**2 half-lives = 75% degraded**  
**3 half-lives = 88% degraded**  
**4 half-lives = 94% degraded**  
**5 half-lives = 97% degraded**

Remember that the amount of chemical remaining after a half-life will always depend on the amount of the chemical originally applied.

## What effect does chlordane have on fish and wildlife?

- Chlordane is moderately toxic to birds (LD50 = 83 mg/kg) (19).
- Chlordane is highly toxic to fish (LC50 = 0.07-0.09 mg/L) (19).
- Chlordane is toxic to bees (19).

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**For more information contact: NPTN**

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