

Appendix A: Background

3. Organophosphate and Carbamate Pesticides Mode of Action

Although organophosphates (OPs) and N-methyl carbamates (CBs) are two distinct chemical classes of insecticides, they have a common mechanism of action.

Mode of action

OPs and CBs are designed to inhibit the normal breakdown of Acetylcholine (ACh). ACh is a neurotransmitter, a chemical produced by a neuron that transmits signals from that neuron to another neuron, an exocrine gland, or a muscle. ACh is released in the junction between the two nerve cells (synapse) where it binds to its receptor on the target cell, inducing its activation and relaying the signal. Acetylcholinesterase (AChE) is an enzyme located in the intercellular space that is responsible for ACh degradation (Figure A3a). OPs and CBs act by occupying and blocking the site where the neurotransmitter attaches to the ChE enzyme. This leads to the buildup of ACh and continuous stimulation of the receptors on the target cells.

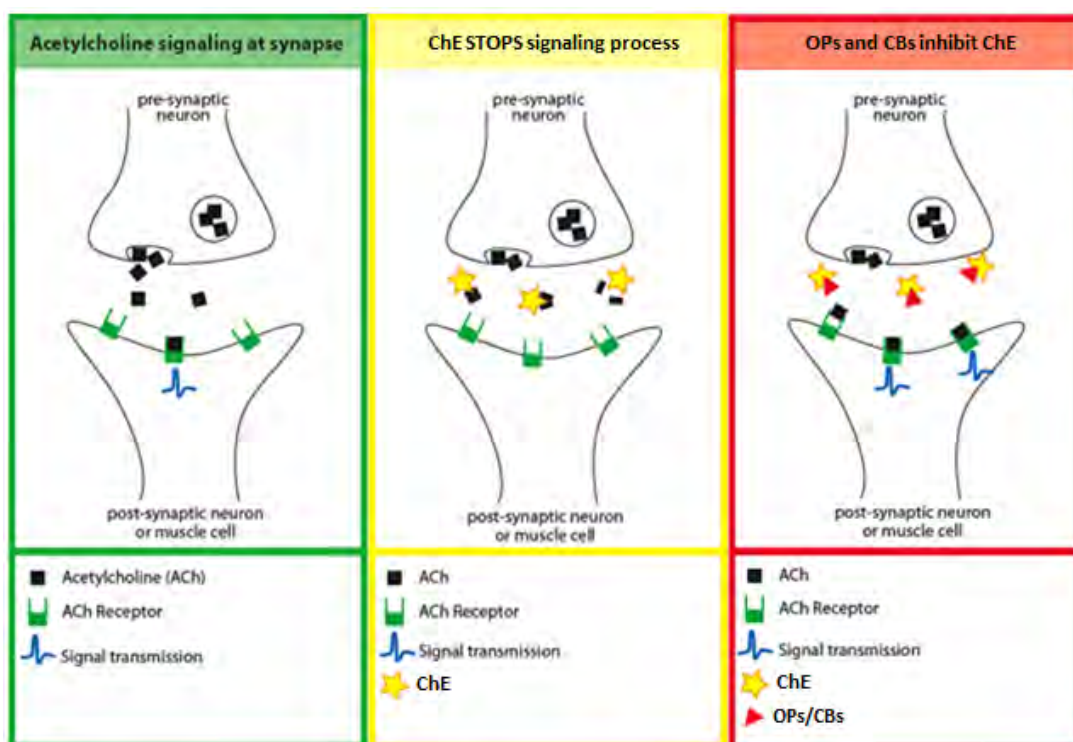


Figure A3a: Mode of action of OPs and CBs on ChE and nerve signal transmission. (Modified from <http://depts.washington.edu/opchild/acute.html>.)

Health effects and toxicity in humans

In humans, ACh plays a vital role in the central and peripheral nervous systems, including contraction of skeletal muscles, regulation of heart and respiratory rates, stimulation of gastrointestinal motility, and many other functions. OPs and CBs inhibit ChE activity resulting in overstimulation of the neurons due to accumulation of ACh at the neuronal junction. Compared to OPs, CBs have a shorter duration of action and generally, a lower toxicity.

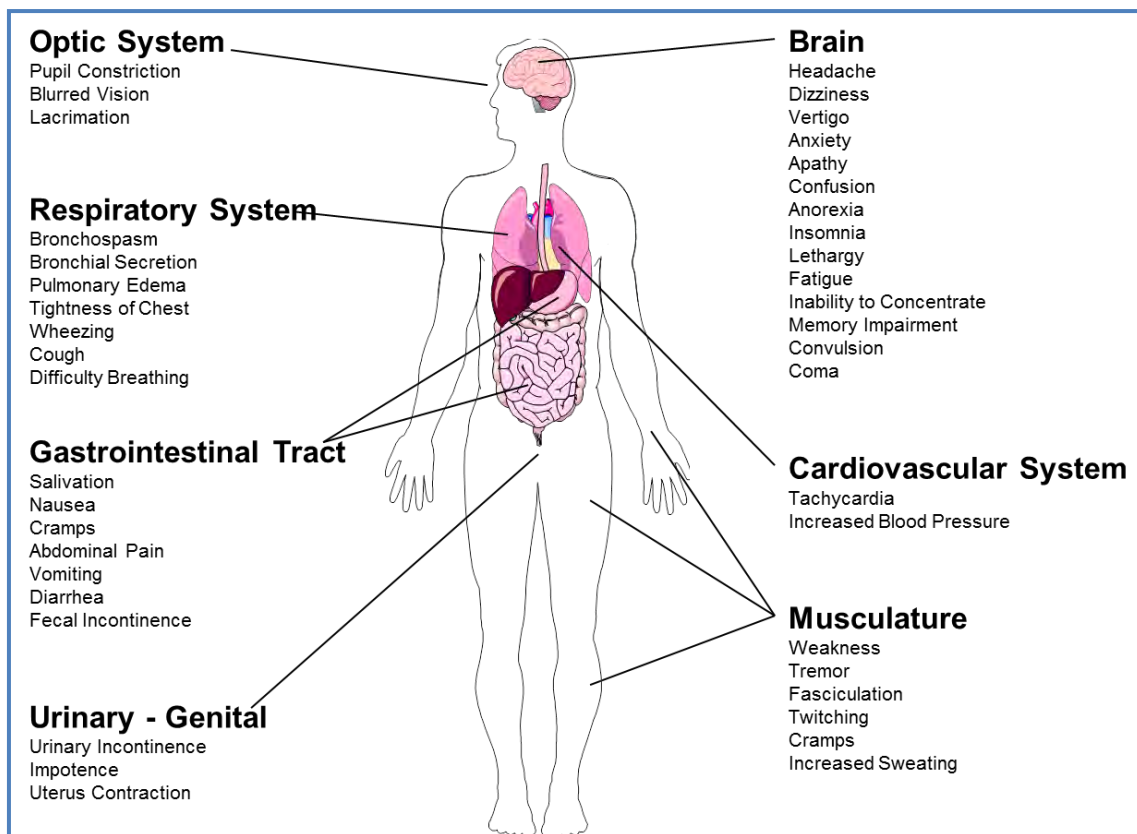


Figure A3b: Most common signs and symptoms of OP and CB toxicity.
(From presentation by Mohamed B. Abou-Donia)

The most common signs and symptoms of acute OP/CB toxicity are slow heart rate, low blood pressure, difficulty breathing, salivation, lacrimation, sweating, abdominal pain, loose stools, muscle weakness, anxiety, and confusion (Figure A3b). Death is usually due to respiratory failure. Signs and symptoms vary with individual age and weight, compound, dose and route of exposure.

The EPA established four toxicity categories for acute hazards of pesticide products. Carbamate and organophosphate insecticides fall into all four categories (Table A3a).

Table A3a: US EPA pesticides toxicity categories			
Categories	Toxicity	Rat Oral LD₅₀	Label
Category I	highly	< 50 mg/kg	Danger
Category II	moderately	50-500 mg/kg	Warning
Category III	low	500-5000 mg/kg	Caution
Category IV	very low	>5000 mg/kg	Not required