Pesticide Lesson Plan

- Theory (Lecture)
  - Issues surrounding pesticide use
  - Kinds of pesticides
  - How they are named
  - Insecticide families
  - Modes of action
- Practice (Lab)
  - Reading the label and legal use
  - Personal safety and pesticide hazards

Mixed Messages

Issues Surrounding Insecticides

- Personal safety
- Impact on environment
- Impact on beneficial insects
- Pesticide resistance
  - Rotate mode of action to reduce resistance

Insecticide Modes of Action

- See the Insecticide Resistance Action Committee Website for updates

http://www.irac-online.org/home.asp

- View poster of modes of action

http://www.irac-online.org/documents/gen_moaposter05.pdf

Responses to Issues

- Vary in toxicity and modes of action
- Vary in effects on non-targets
- Vary in longevity
- Vary in compatibility with biological control and other non-targets
- Most effective long term use is to choose the least toxic material needed to get the job done

Definitions- Target Classifications

Pesticide = Killer of pests

What do each of these pesticides kill?

insecticide, herbicide, fungicide,
miticide, rodenticide, molluscicide
nematicide, bacteriacide, piscicide

Modes of Lethal Exposure to Insects

- Contact insecticide - kills on contact
- Stomach poison – must be eaten

Fate of Insecticide on Plants

- Contact- stays where it is
- Systemic – is taken up by plant roots
- Lamellar systemic- moves through leaf tissue to other side of leaf.

Insecticide Nomenclature

- Carbamate - Pesticide Family
- Sevin - Brand (trade) name - Sevin
- Carbaryl - EPA approved common name
- 70 WP - Formulation abbreviation
  - 70% wettable powder by weight

Classifications of Pesticides

- By source or chemical structure (Pesticide Family)
  - Physical properties, Origin
- By modes of action
  - Important for preventing resistance and assessing non-target effects
- Conventional vs Biorational
  - Legal implications -1996 Food Quality Protection Act
  - Compatibility with biological control

Chemical Families

- Inorganics
- Oils
- Salts of Fatty Acids (soaps)
- Botanicals
- Microbial toxins
- Synthetic organics
- PIPS – Pesticides in Plants (GMO's)

http://ohioline.osu.edu/b504/b504_6.html

Chemical Families

- Inorganics
  - Boric acid
  - Diatomaceous earth
  - Sulfur
  - Calcium and Lead Arsenates

Chemical Families

- Oils
  - Dormant season grade
  - Summer season grade
  - Citrus oil
- Salts of Fatty Acids (soaps)
  - Insecticidal soaps

http://ohioline.osu.edu/b504/b504_13.html

Chemical Families

- Botanicals
  - Neem (Azadiractin)
  - Pyrethrum
  - Rotenone
  - Nicotine
  - Ryania

http://ohioline.osu.edu/b504/b504_13.html

http://ohioline.osu.edu/b504/b504_6.html

Chemical Families

- Microbial toxins
  - Bacillus thuringiensis
  - Avermectin B
  - Spinosyns

http://ohioline.osu.edu/b504/b504_13.html

Synthetic Organic Pesticides

- Organochlorines - (DDT, Lindane,)
- Organophosphates (Malathion, acephate, diazinon)
- Carbamates (carbaryl, methiocarb)
- Pyrethroids (permethrin, bifenthrin)
- Chloronicotynils and Neonicotynils (imidacloprid)
- Insect Growth Regulators

http://ohioline.osu.edu/b504/b504_6.html

More Synthetic Organics

- Fiproles -(fipronil)
- Pyrroles -Chlorfenapyr (Pylon))
- Pyrazoles (Fenpyroximate)
- Pyradizones -Pyradiben(Sanmite)
- Quinazolines (Fenazaquin, Hydramethalnon)

Modes of Action of Insect Toxicants

- Physical toxicants
- Antifeedants
- Axonic poisons (nerve poison)
- Synaptic poisons (nerve poison)
- Metabolic inhibitors
- Cytolitic toxins
- Muscle poisons
- Alkylating agents
- Disruptors of molting, metamorphosis and cuticle formation (Insect Growth Regulators)

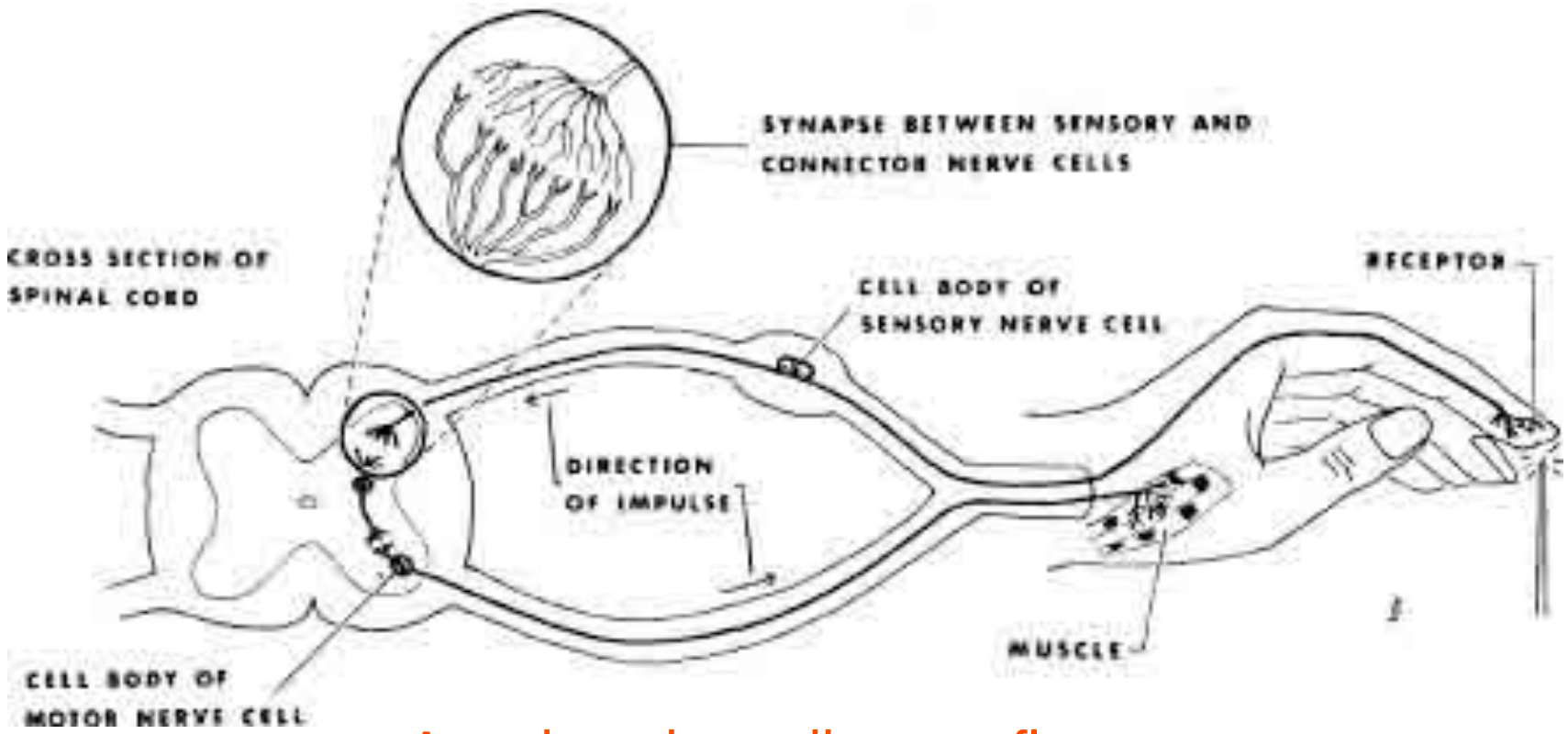
Kinds of Toxicants - Physical

- Physical toxicants – mechanically block physiological process
  - Smothering agents – oils, soaps
  - Abrasive substances that scratch exocuticle
    - diatomaceous earth, silica gel

Kinds of Toxicants - Antifeedants

- Antifeedants – repell or are distasteful to insects
  - Neem - Azadirachtin active ingredient

Nerve Poisons: Review of Nerve Impulse Transmission



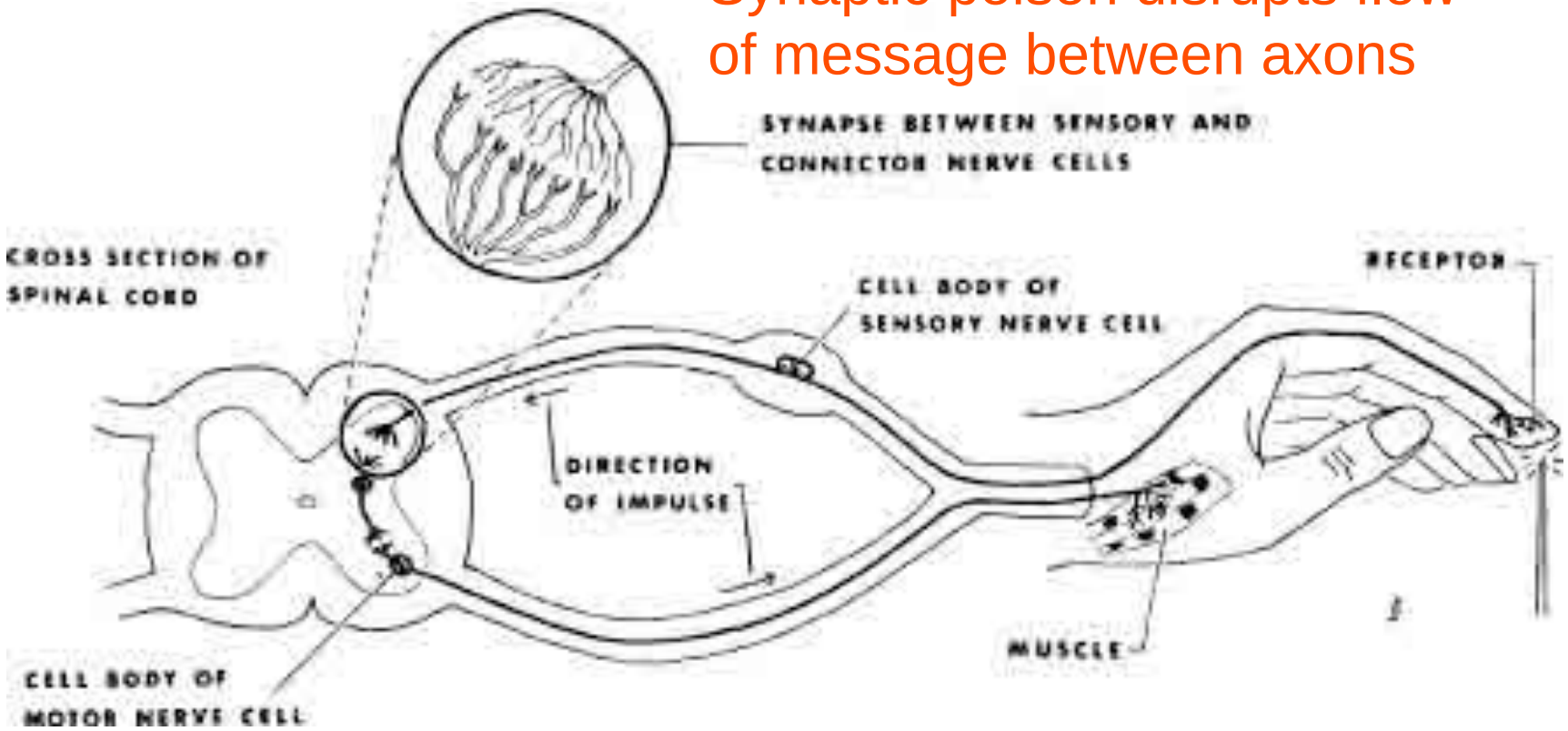
Axonic poison disrupts flow of charge through axon

Kinds of Toxicants – Nerve Poisons

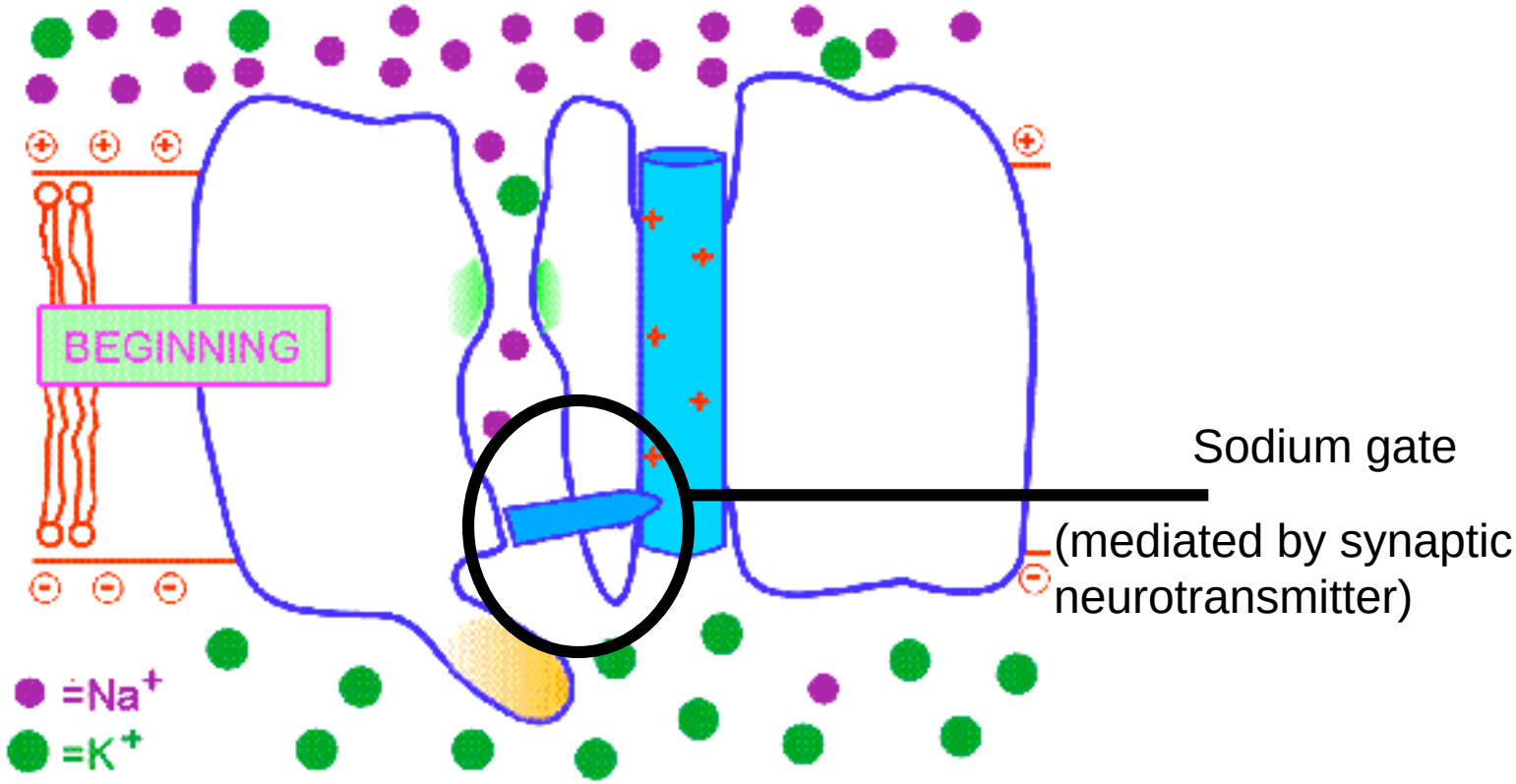
- Axonic poisons
  - Sodium channel blockers (Pyrethroids-, DDT)
  - Disrupt movement of sodium through axon by clogging axon

Review of Nerve Impulse Transmission

Synaptic poison disrupts flow of message between axons



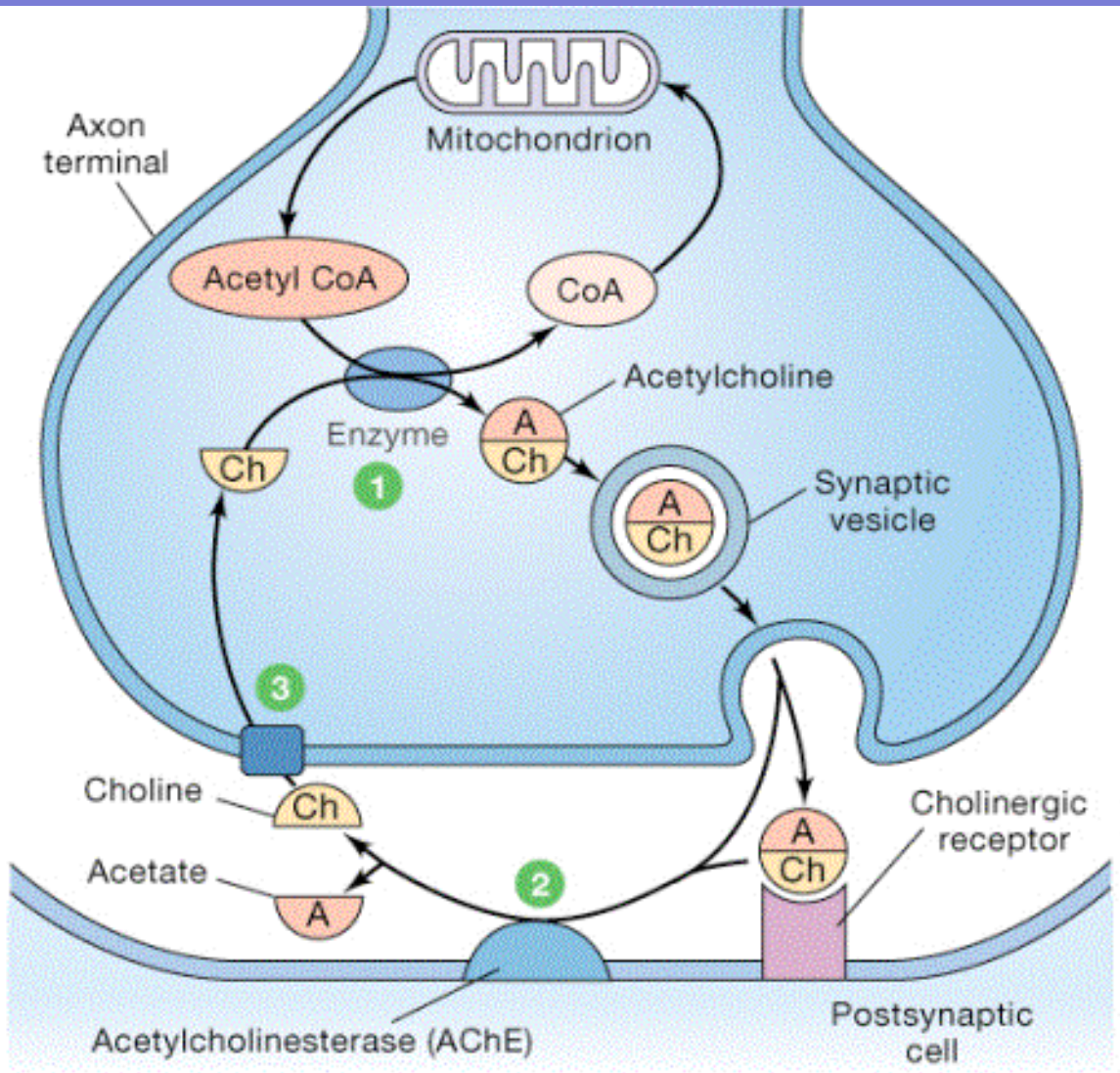
Impulse transmitted by polarization wave in sodium/ potassium channel



Blocking the sodium gate blocks the message

Source: http://courses.washington.edu/conj/membrane/chan.gif

Aceytlcholine and Acetylcholinesterase Mediated Synaptic Transmisssion



1. **Acetylcholine** (ACh) is made from choline and acetyl CoA.

2. In the synaptic cleft ACh is rapidly broken down by the enzyme **acetylcholinesterase.**

3. Choline is transported back into the axon terminal and is used to make more ACh.

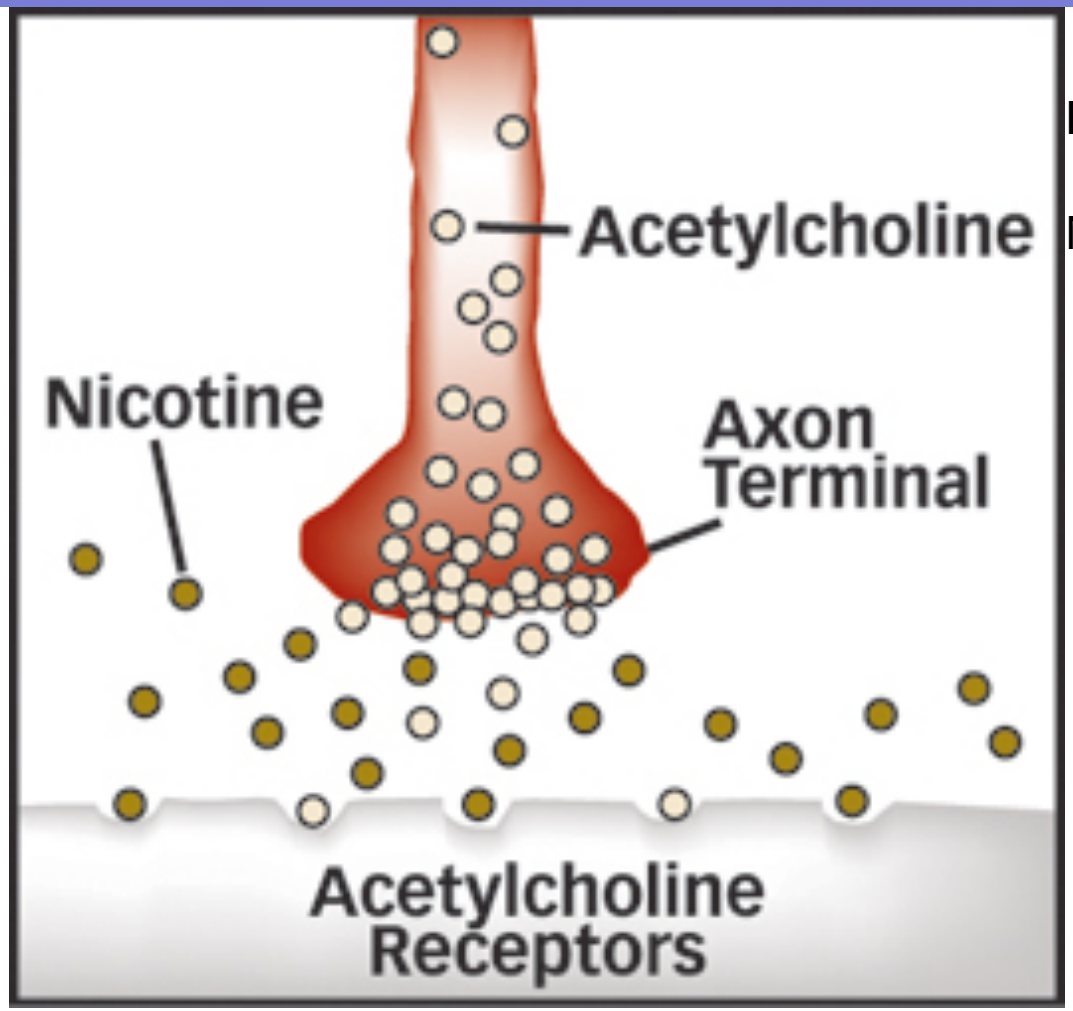
Five general types of synaptic neurotransmitters are known

- Cholinergic
- Glutaminergic
- Indoaminergic
- Catecholinergic
- Octopaminergic

Kinds of Toxicants – Chemical Families of Nerve Poisons

- Synaptic poisons –Block chloride channel by interfering with synaptic neurotransmitters
  - Chloronated hydrocarbons (some)
  - Organophosphates
  - Carbamates
  - Avermectins,
  - Fiproles
  - Nicotinoids, neonicotinoids, spinosyns

Example: Nicotine blocks acetylcholine receptors



Examples:

Nicotene sulfate

Anyone really need a cigarette????

Carbamate vs Organophosphate Modes of Action

- Both reduce ability of acetylcholinesterase (Ach_ase) to cleave acetyl choline BUT,
- Organophosphate phosphorylation of Ach_ase is not reversible.
- Carbamylation of Ach_ase is reversible.

Kinds of Metabolic Inhibitors

- Mitochondrial electron transport system blockers
  - Insects unable to exchange biochemical energy (HCN), Rotentone, Organotins, Pyrroles, Pyrazoles Pyridazaones, Quinazolines)
- Mixed function oxidase inhibitors
  - Disrupt ability to produce detoxification enzymes (added as synergists to prevent pesticide breakdown)
- Glycolysis inhibitors (examples??)
  - Poison sugar digestion pathway

Kinds of Toxicants

- Cytolytic
  - Destroy tissue of critical cells
    - (eg. Intima- lining of insect gut)
- Muscle poisons
  - Stop muscle contraction
- Alkylating agents
- Insect Growth Regulation Disruptors (IGRs)

Plant Incorporated Pesticides PIPS

Genetically modified plants that produce their own pesticides

- BT Corn… etc…

FQPA Defined Categories

- Conventional- tend to be broad spectrum killing pests and natural enemies, and have long residual activities many are neurotoxins.
- Biopesticide (biorational)- tend to be more selective and with short residual activities. Includes PIPS.

See EPA website:

http://www.epa.gov/pesticides/biopesticides/

Toxicity and Compatibility of Common insecticides

Disulfoton vs Dimilin ?

http://www.entomology.umn.edu/cues/IPM-Pesticides/IPM-pesticides.html

Study Questions

- Distinguish between a pesticide family and pesticide mode of action.
- Know differences between modes of action associated with neurotoxins, physical toxicants, metabolic inhibitors and insect growth regulators
- Know how the EPA distinguishes between conventional and biorational pesticides and its relationship to FQPA.
- How does using the least toxic material, reduce environmental problems associated with pesticide use?
- How does rotating with pesticides of different modes of action reduce problems with pesticide resistance.
- Know that the ability of different pesticides to attack different parts of each neurotransmitter system allows the potential for pesticides with different modes of action