

Insect Control Methods

Chemical Control of Insect Pests

(Ent-401)

Dr. Sajjad Ali

Assistant Professor

Entomology

3.1 Chemical control of insect-pests

It is the control of insect pests with the help of pesticides

Pesticide:

Any chemical, substance or mixture of substances intended for preventing, killing or repelling any pest



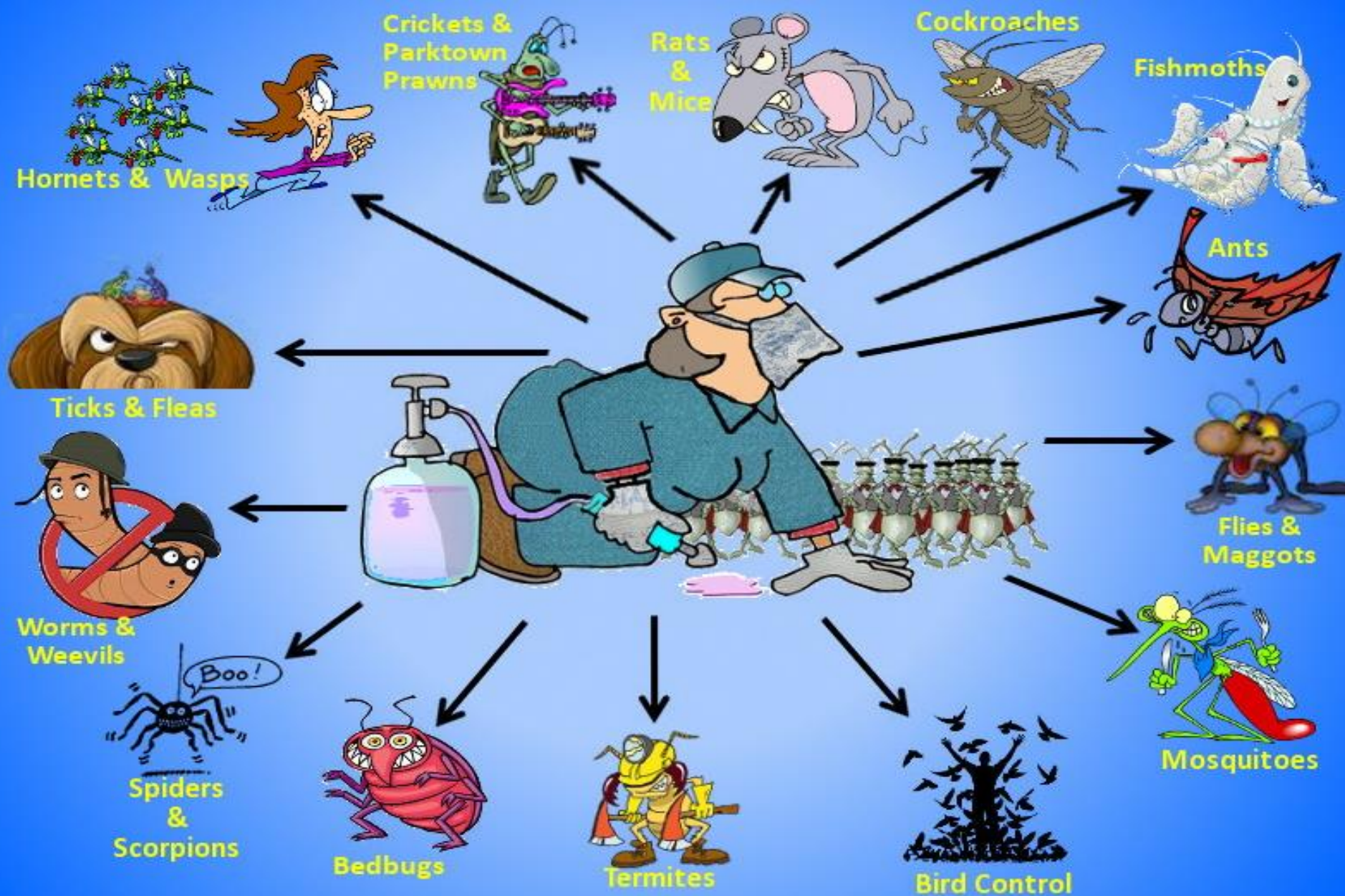
3.1.1 Classification of pesticides

Generally pesticides can be classified as:

- **Insecticides** (Chemicals used to control **insects**)
- **Rodenticides** (Chemical used to control **rodents** e.g. Sodium cyanide, Zinc phosphide)
- **Acaricides** (Chemicals used to control **mites** e.g. Chlorobenzilate, Dicofol, Ethion etc.)
- **Weedicides** (Chemicals used to control **weeds**)
- **Fungicides** (Chemicals used to control **fungi**)



3.1.1 Classification of pesticides



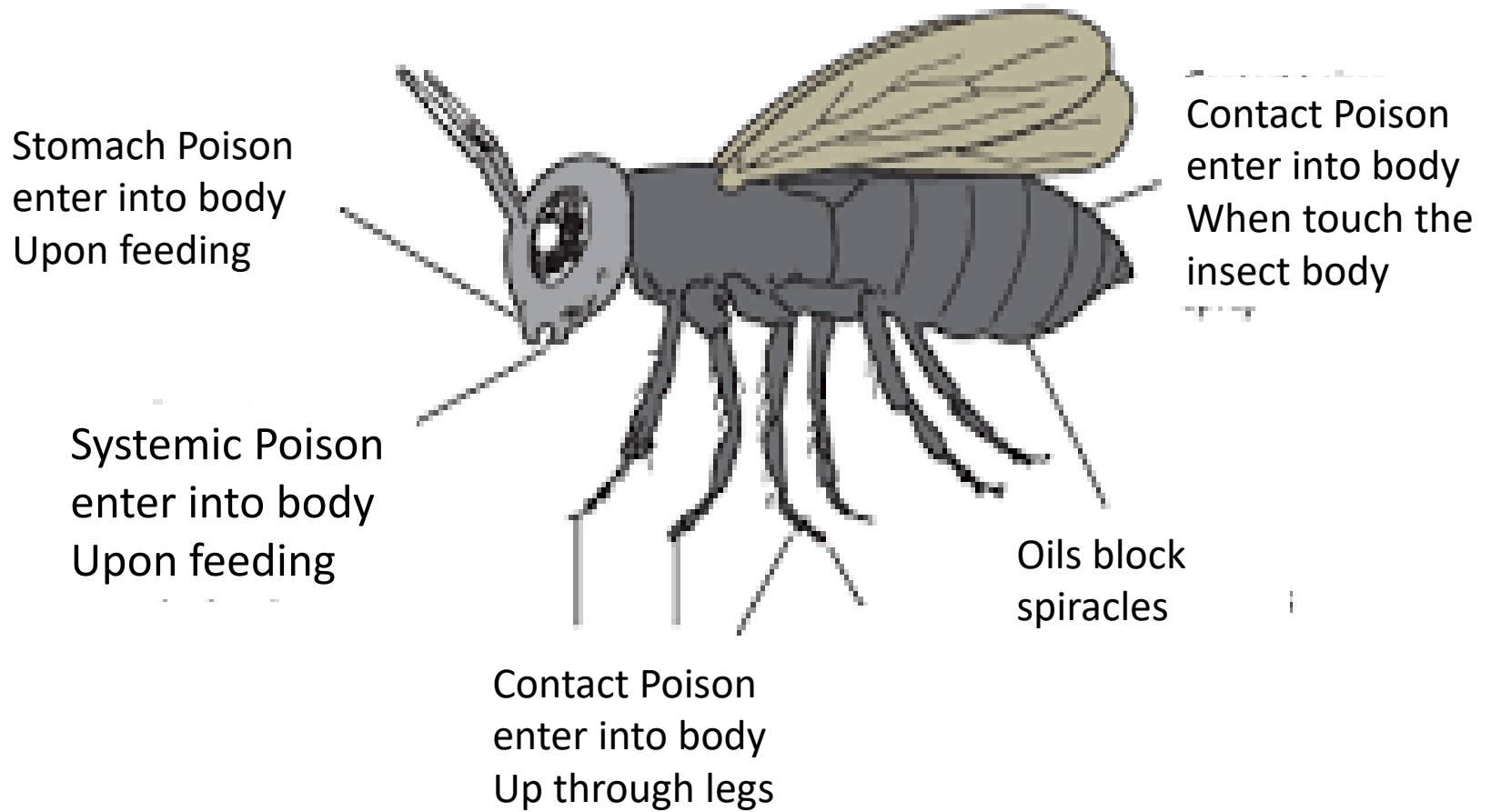
3.1.2 Classification of insecticides

Insecticides may be classified based on the followings:

- ☐ Mode of entry
- ☐ Mode of action
- ☐ Chemical Chemistry
- ☐ Formulation



3.1.2.1 Insecticide Classification (Mode of entry)



3.1.2.1 Insecticide Classification (Mode of entry)

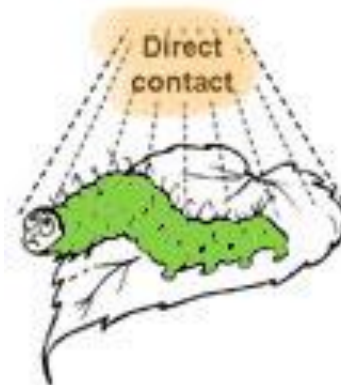
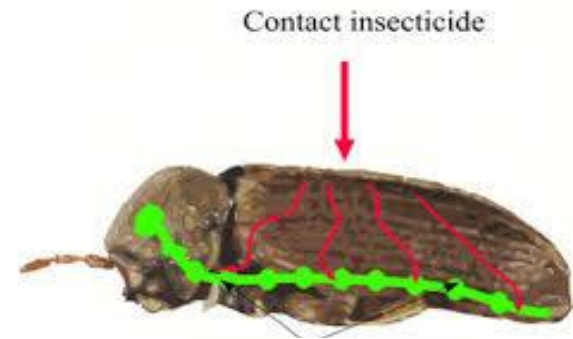
1. Stomach insecticides

- Enter into stomach with food and kill the insect by chemical action
- Applied on plants for the control of chewing insect pests



2. Contact insecticides

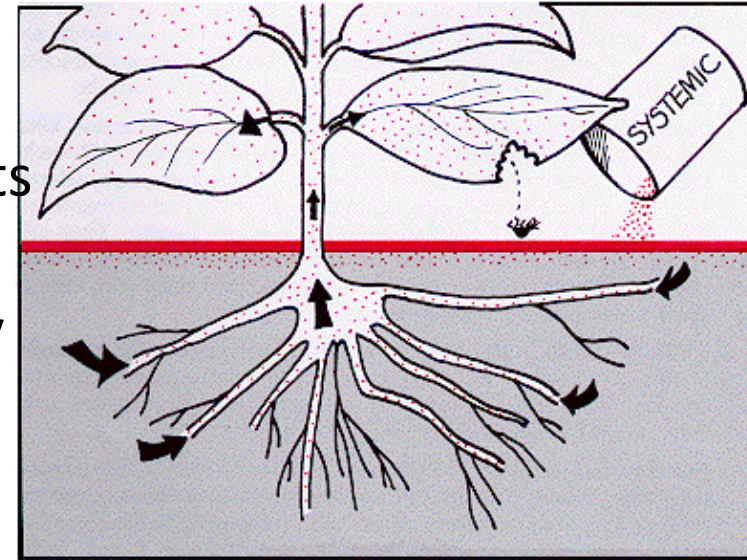
- Enter in insects body through body wall when insect come in contact
- Applied directly on insects when they are damaging the crops
- Used against soft bodied insects



3.1.2.1 Insecticide Classification (Mode of entry)

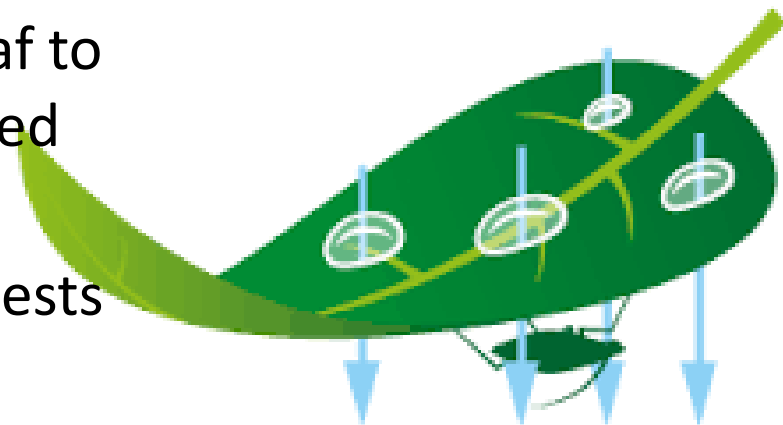
3. Systemic insecticides

- Applied through soil or by spraying
- Absorbed by roots and other plant parts and translocated to all parts of plant
- When insects feed on such plants, they are killed
- Best against sucking insect pests and internal borers



4. Translaminar insecticides

- These translocate from one side of leaf to the other side i.e. these are transported across lamina
- Very effective against sucking insect pests



3.1.2.1 Insecticide Classification (Mode of entry)

5. Fumigants

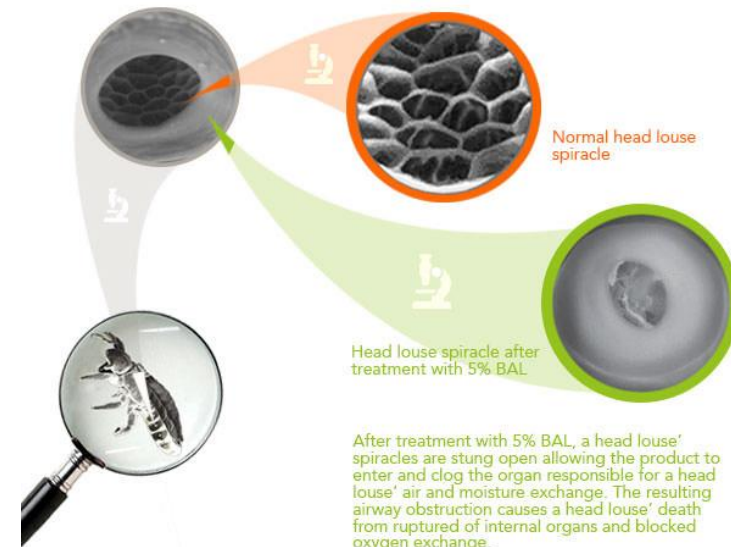
- Mostly found in solid form which give fumes into air at ordinary room temperature
- Enter in the body of insects through spiracles
- E.g. Aluminium phosphide, Methyl bromide



3.1.2.2 Insecticide Classification (Mode of action)

1. Physical insecticides

- Kill insects through their physical action
- These block the spiracles and cause suffocation and death of insects
- Their action is physical rather chemical e.g. Oils



2. Muscle poisons

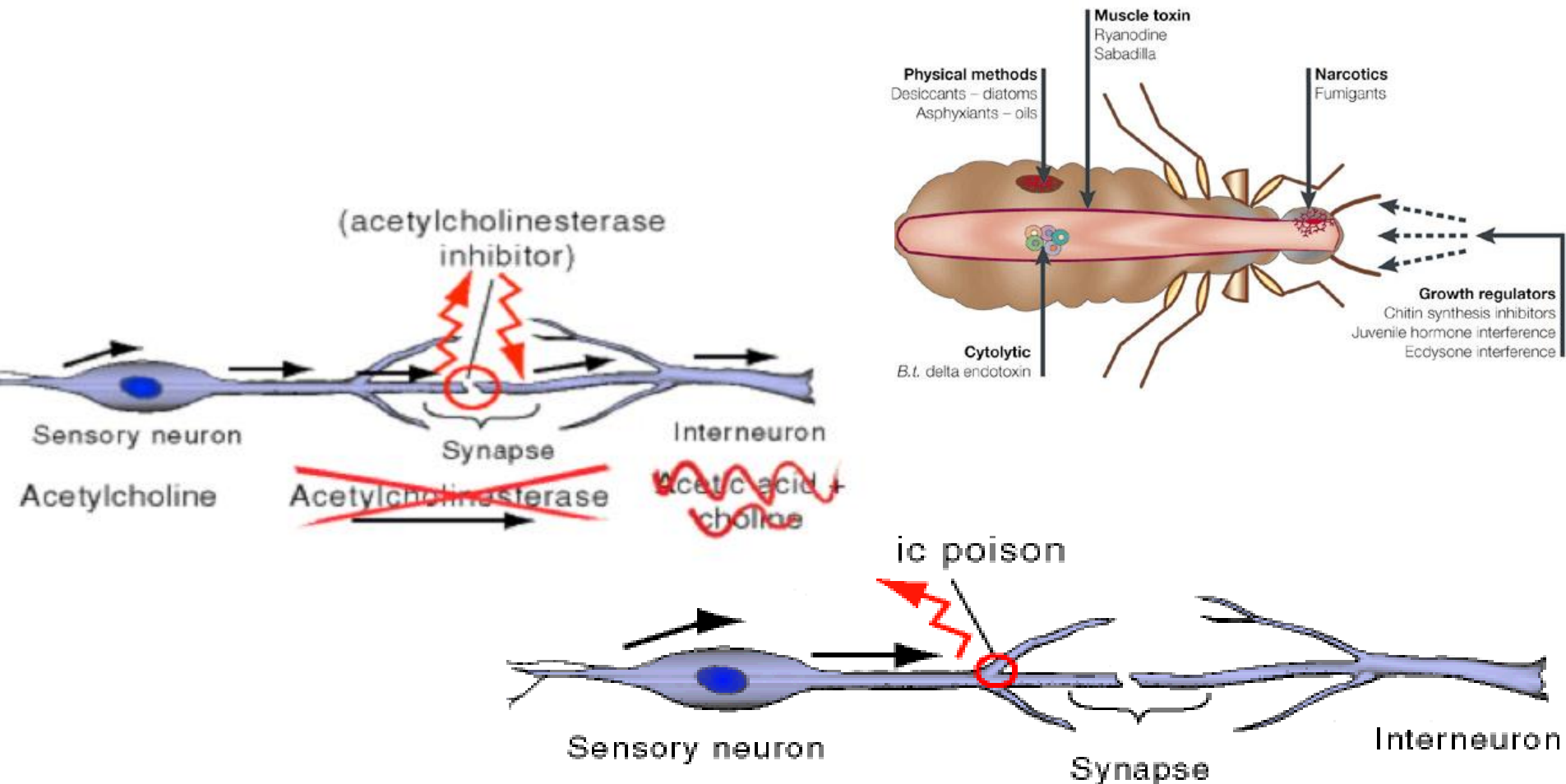
- Affect the muscles of insects
- These rupture the muscle membrane which increases the oxygen utility
- Insects are killed by extra ordinary respiration e.g. Botanical insecticides



3.1.2.2 Insecticide Classification (Mode of action)

3. Nerve poisons

- Affect the insect nervous system and cause death
- E.g. Narcotic poisons, Axonic poisons and Synaptic poisons

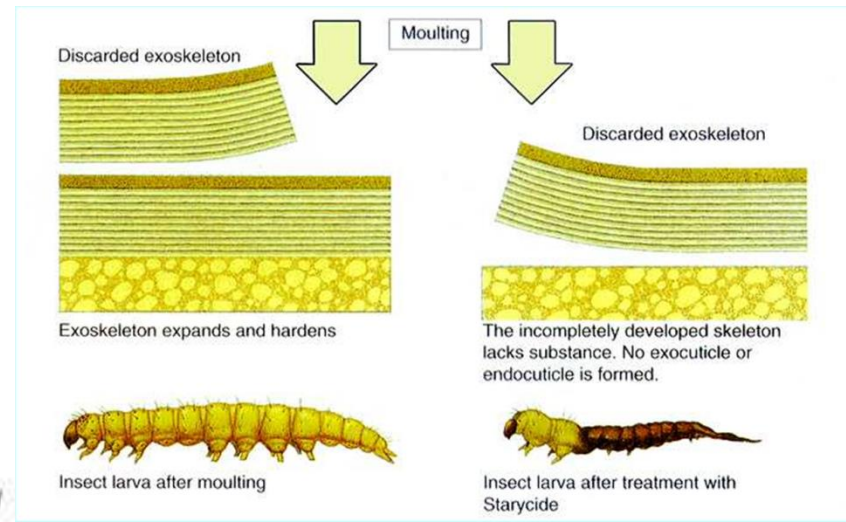
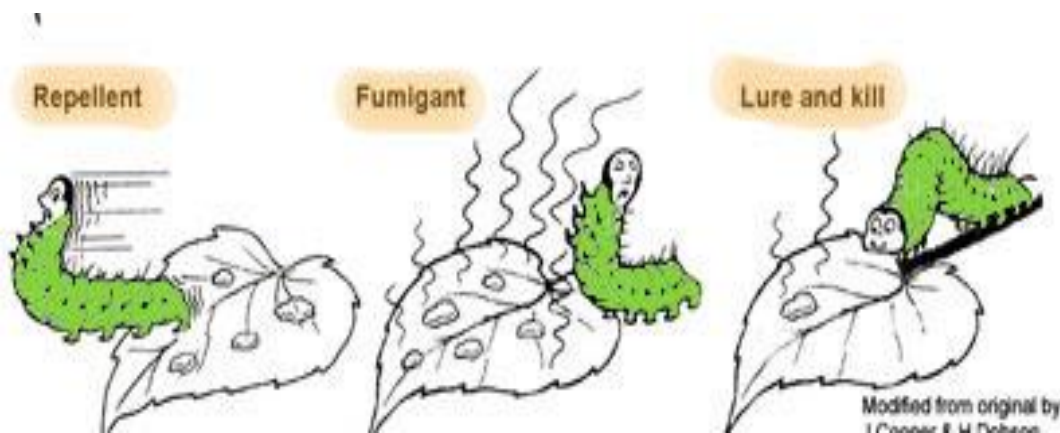


3.1.2.2 Insecticide Classification (Mode of action)

4. Miscellaneous insecticides

- a) Insect attractants; e.g. Methyl eugenol, Gyplure, Hexap lure
- b) Insect repellents; e.g. Creosote, Mercurous chloride, Trichlorobenzene
- a) Insect growth regulators; examples are as under

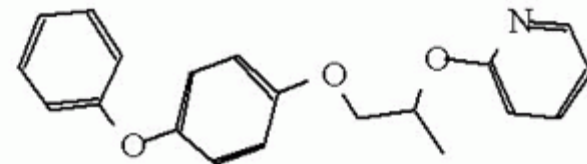
Chitin synthesis inhibitor: Group of insecticides which inhibit the synthesis of Chitin (Buprofezin, Benzoyl phenyl urea)



3.1.2.2 Insecticide Classification (Mode of action)

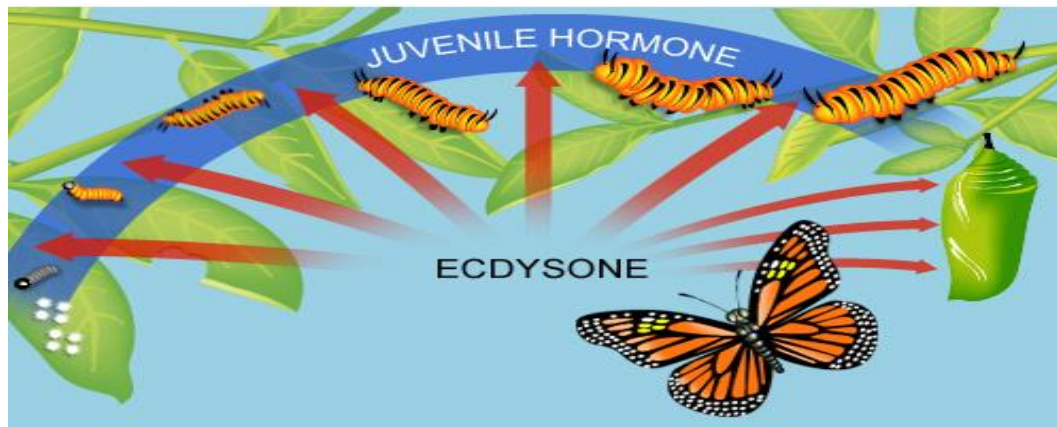
Juvenile hormone mimics/Analog: **PYRIPROXIFEN**

- Group of insecticides which mimic with juvenile hormone and affect the hormonal balance
- Ultimately metamorphosis is disturbed (Fenoxycarb, Pyriproxyfen)

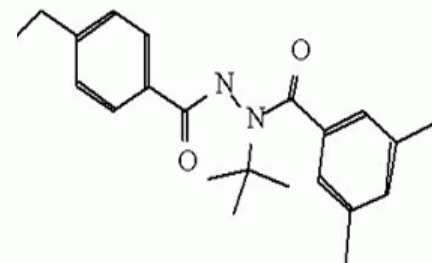


Ecdysone agonists:

- These bind the ecdysteroid receptors and affect the physiology and biochemical processes (RH5849, Tebufenozide)



TEBUFENOZIDE



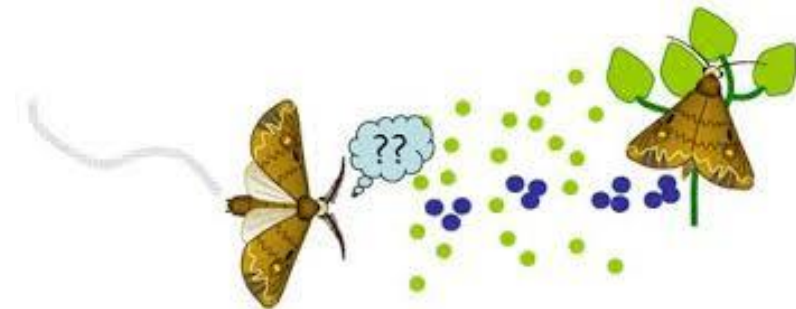
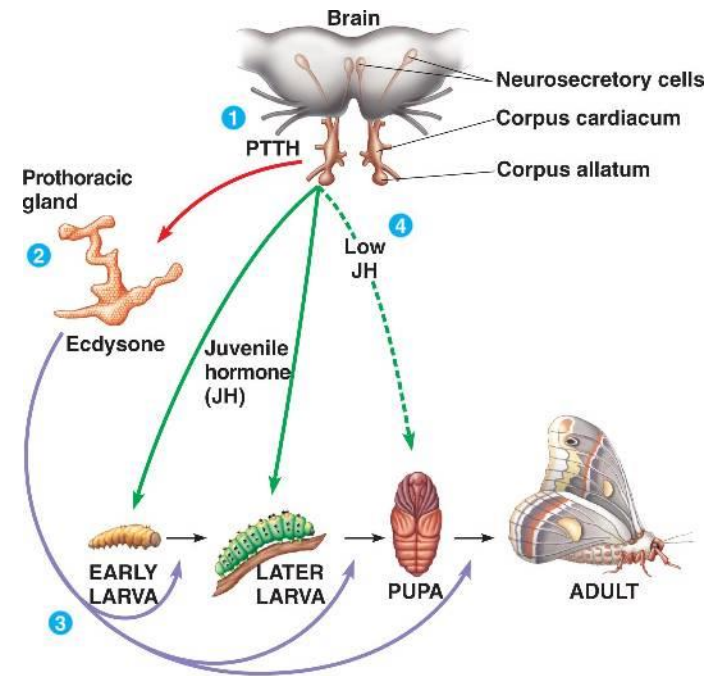
3.1.2.2 Insecticide Classification (Mode of action)

Hormones:

- Secretions produced by organisms into their blood and act at a place different from their origin are called hormones

Pheromones:

- Secretions which are thrown outside the body are called pheromones.
- Used to communicate between individuals of same species

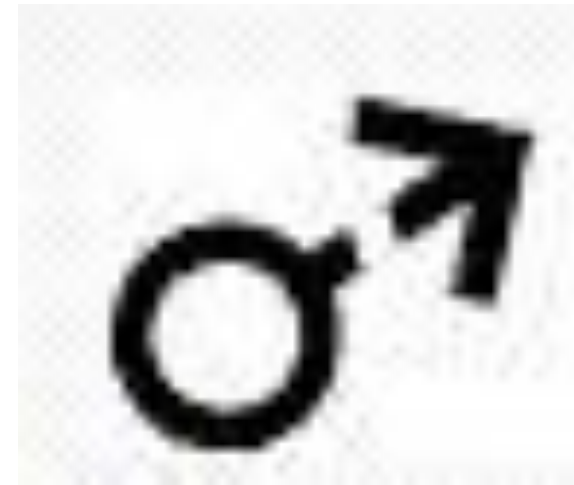
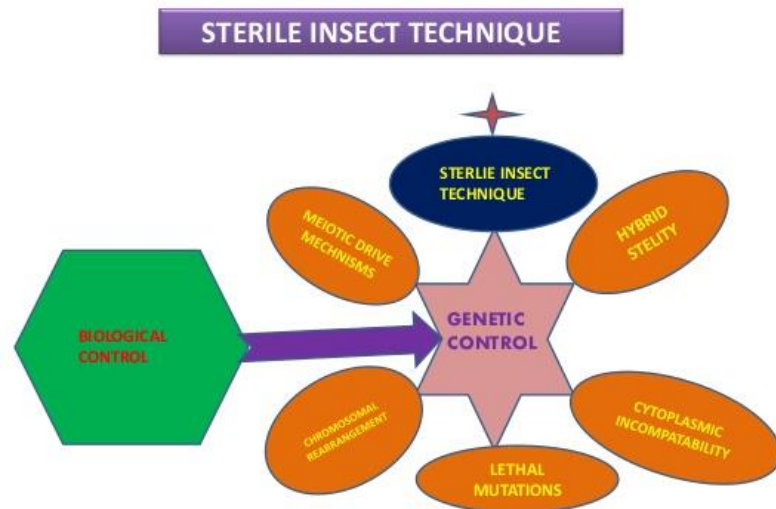


3.1.2.2 Insecticide Classification (Mode of action)

Chemosterilants:

- Chemicals used to cause permanent or temporarily sterility of one or both the sexes of insects
- Mating of sterilized insects with fertile insects produces no offspring
- If no. of sterile insects is kept constant, %age of sterile insects will increase and fewer offsprings will be produced in each successive generation

Types: Antimetabolites and alkylating agents

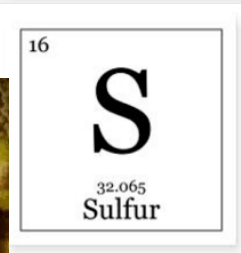
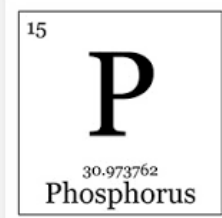
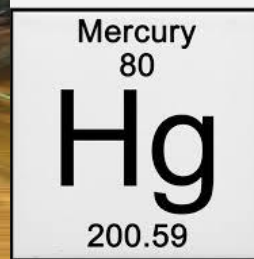


3.1.2.3 Insecticide Classification (Chemistry)

On the basis of chemical nature, insecticides are classified as follows:

3.1.2.3.1 Elements:

- e.g. Sulphur, Phosphorous, Mercury



3.1.2.3.2 Inorganic insecticides:

Some of the earlier insecticides ever used in this category are:

- Arsenicals** (lead arsenate, sodium arsenites)
- Fluorides** (Sodium fluoride, barium fluosilicates)
- Seliniums** (sodium selenate)

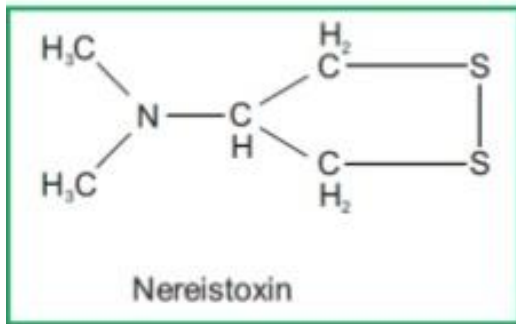


3.1.2.3 Insecticide Classification (Chemistry)

3.1.2.3.3 Organic insecticides (Natural organics)

a) **Animal origin;** e.g. Fish oils, Nereistoxin (toxin of marine annelid)

- Action of oils is of physical in nature
- Spiracles of insects are filled by oils and blockage of air in tracheae cause suffocation which results in death of insects



b) **Plant origin;** e.g. rotenone, nicotine, ryania, derris, pyrethrums, limonene, azadirachtin etc.

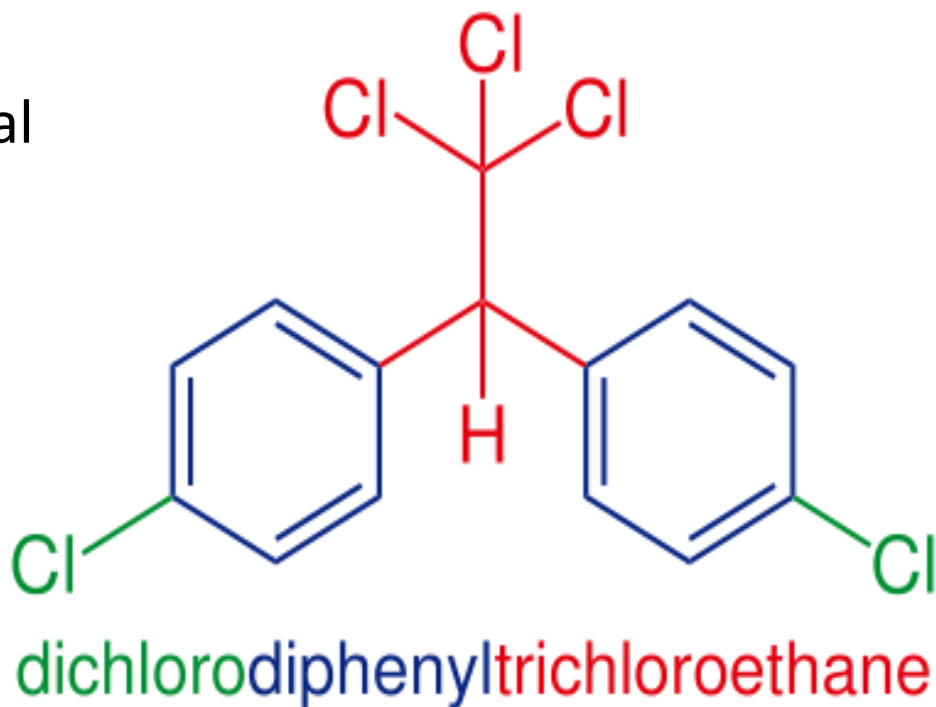


3.1.2.3 Insecticide Classification (Chemistry)

Synthesized organics

a) Organo-chlorine insecticides (chlorinated hydrocarbons)

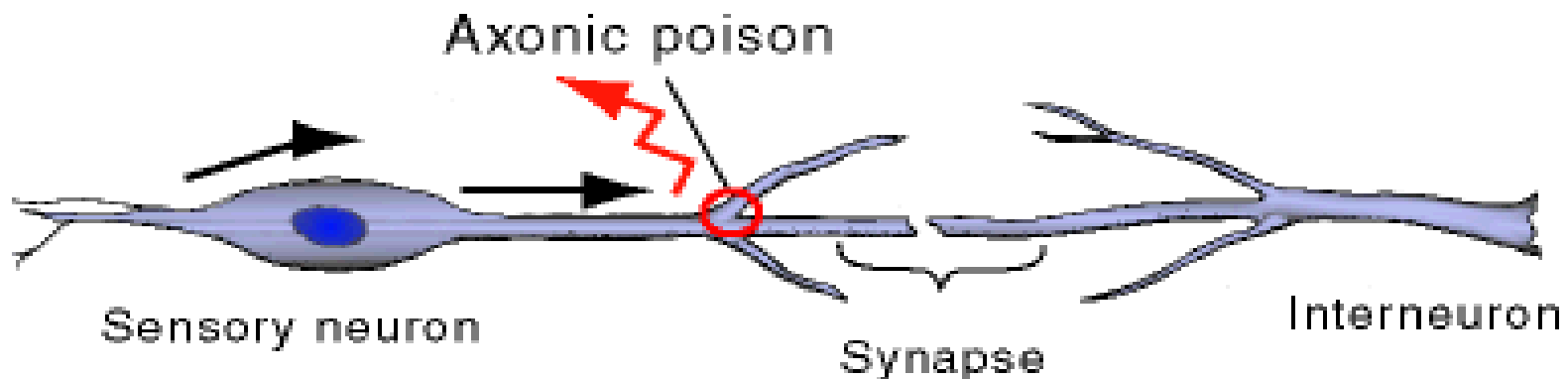
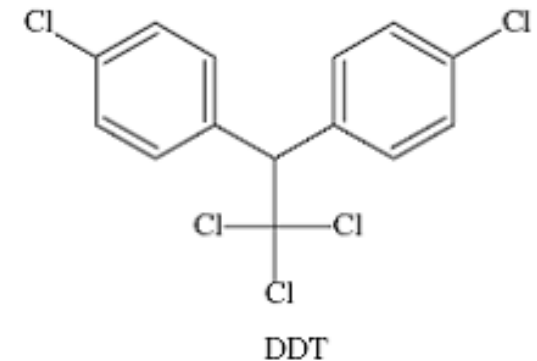
- Chlorine is important part of these chemicals
- These take a long time to disappear from environment
- These accumulate slowly in the bodies of insects and even in higher animals
- These unstabilize the peripheral nervous system
- Cause hyper toxicity, paralysis and finally death of insects



3.1.2.3 Insecticide Classification (Chemistry)

Conti...

- If sudden poisoning occurs in human being, atropine sulfate or raw egg and milk can be used as **Antidotes**.
- E.g. DDT family, HCH family, Aldrin, Dieldrin, Heptachlor etc.
- These are axonic nerve poisons.



3.1.2.3 Insecticide Classification (Chemistry)

Merits of OC's

- Fat soluble
- Not dissolved in Water
- Stomach Poison(Mode of Acton)
- Contact Poisons(Mode of Entry)
- Few have fumigant action
- Non phyto-toxic except cucurbits

De-merits of OC's

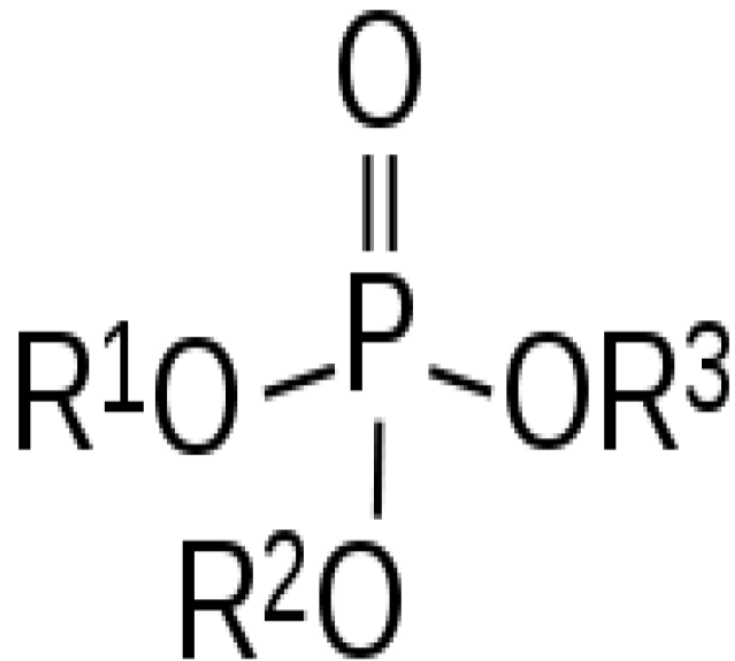
- Highly Persistent
 - Lipophilic
 - Residual effect
- Highly mammalian toxicity
- Carcinogenic
- Mutagenic



3.1.2.3 Insecticide Classification (Chemistry)

b) Organophosphates insecticides

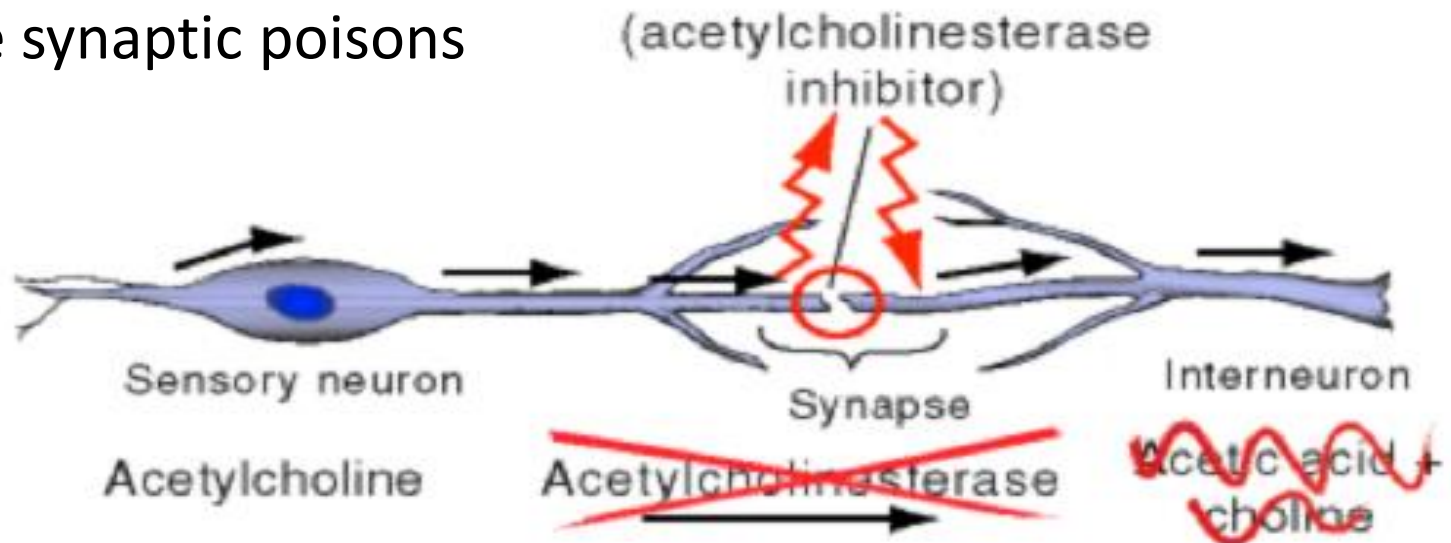
- Phosphorous is important part of these chemicals
- These are not persistent as chlorinated hydrocarbons
- These may be contact stomach or fumigants in action
- These insecticides less accumulate in fat bodies of animals
- These inhibit the production of cholinesterase enzyme
- This enzyme dissolves the acetylcholine (liquid) after passing a pulse from synapsis



3.1.2.3 Insecticide Classification (Chemistry)

Conti...

- Inhibition of this enzyme results in continuous passage of pulse and disturb the insect continuously
- Finally, death of insect occurs
- Toxicity of these chemicals varies from extremely hazardous to slightly hazardous chemicals
- These are synaptic poisons



3.1.2.3 Insecticide Classification (Chemistry)

Conti...

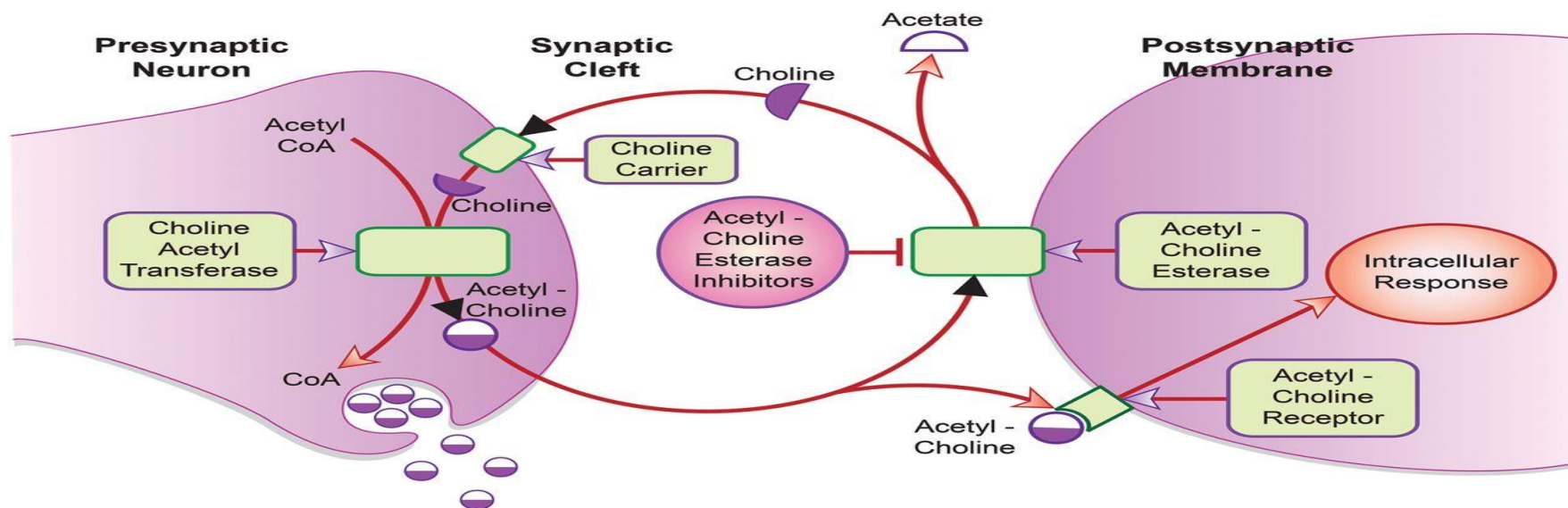
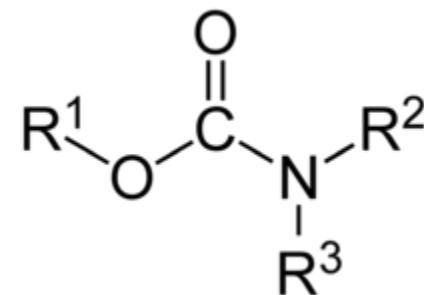
Organophosphates are further classified into following categories:

- a) **Pyrophosphates** (Derivatives of pyrophosphoric acid e.g. Schradan)
- b) **Phosphates** (Derivatives of phosphoric acid e.g. Dichlorvos, Monocrotophos etc.)
- c) **Phosphorothioates** (Derivatives of phosphorothioic acid e.g. Parathion, Chlorpyrifos, Profenophos etc.)
- d) **Dithiophosphates** (Derivatives of dithiophosphoric acid e.g. Phorate, Malathion etc.)
- e) **Phosphonates** (Derivatives of phosphonic acid e.g. Trichlorfon)
- f) **Phosphorothioamidates** (Derivatives of phosphorothioamidic acid e.g. Methamedophos, Acephate)

3.1.2.3 Insecticide Classification (Chemistry)

c) Carbamates

- Relatively new group of synthetic insecticides
- Compounds are strong alkalis
- Derivatives of **carbonic acid**
- Chemical properties similar to OP's
- Toxicity is a bit more than organophosphate
- These are Cholinestrase Inhibitor

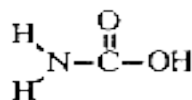


3.1.2.3 Insecticide Classification (Chemistry)

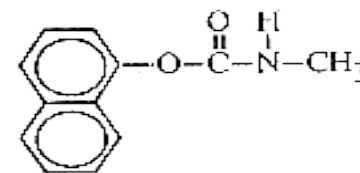
Carbamates are

Further classified into following categories:

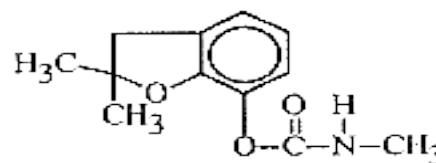
- i. **Heterocyclic carbamates** (Pirimicarb, Carbofuran, Bendiocarb, Carbosulfan, Furathiocarb)
- ii. **Phenyl carbamates** (Carbaryl, Propoxur, Isoprocarb, Fenobucarb, Methiocarb)
- iii. **Oxime carbamates** (Aldicarb, Aldoxycarb, Methomyl, Oxamyl, Thiodicarb)



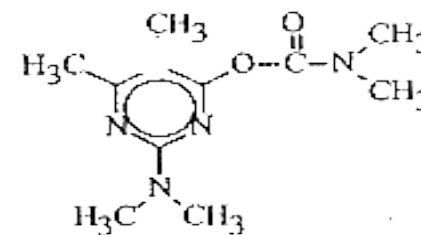
Carbamic acid



Carbaryl



Carbofuran



Pirimicarb

3.1.2.3 Insecticide Classification (Chemistry)

d) Synthetic pyrethroids

- **Pyrethroid** is an organic compound similar to the natural pyrethrins produced by the flowers of pyrethrums.
- Pyrethroids now constitute the majority of commercial household insecticides.
- They may also have insect repellent properties
- These are generally harmless to human beings in low doses but can harm sensitive individuals.
- Easily degradable
- Have low toxicity to man and other vertebrate animals
- Very effective against flying insects
- Have a wide range of effectiveness



3.1.2.3 Insecticide Classification (Chemistry)



I. PYRETHRINS



ANALOGUE

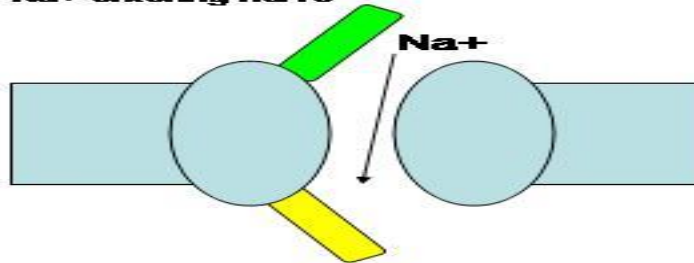
II. SYNTHETIC PYRETHROIDS

3.1.2.3 Insecticide Classification (Chemistry)

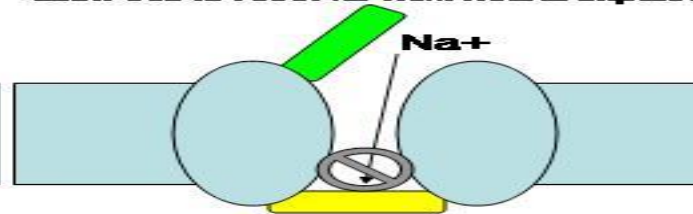
Mode of action

- Prevent the close of sodium channels present in insect axonal membrane.
- This membrane has a tiny hole which helps to pass away the partially charged water molecules from a sodium ion and create a favourable way for sodium ions to pass.
- When the toxin keeps the channels in their open state, the nerves cannot repolarize, leaving the axonal membrane permanently depolarized, thereby paralyzing the organism.

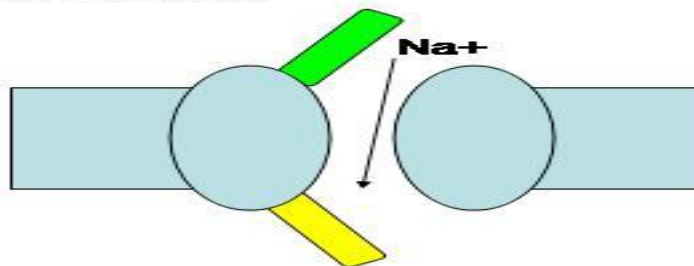
NORMAL
Increase in membrane potential with Na^+ entering nerve



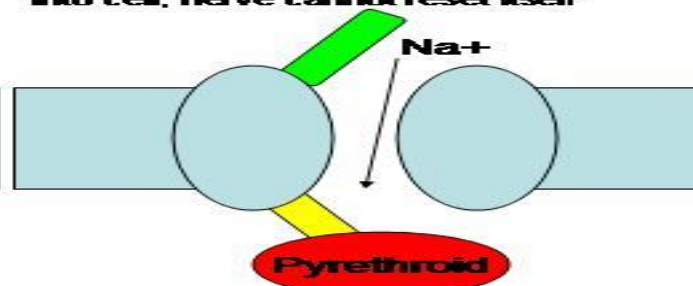
Gate shuts down Na^+ travel inside to allow cell to reset for next neural impulse



Insecticide



Gate cannot shut, Na^+ continues to travel into cell, nerve cannot reset itself



3.1.2.3 Insecticide Classification (Chemistry)

Synthetic Pyrethroids

Further classified into following categories:

- i. **Permethrin** (Ambush, Coopex)
- ii. **Cypermethrin** (Ripcord, Cymbush, Arrivo)
- iii. **Deltamethrin** (Decis, Leopard, Perfect, Lajawab)
- iv. **Fenvalerate** (Sumicidin, Fenstar)



3.1.2.4 Insecticide Classification (Formulations)

Pesticide Formulations: Definitions

- **Active Ingredient (Ai)** - the actual chemical in the product mixture that controls the pest
- **Inert Ingredient** - other materials added with the AI when the product is formulated
- **Phytotoxicity** - plant damage
- **Adjuvant** - product added to spray tank to assist pesticide in its application

3.1.2.4 Insecticide Classification (Formulations)

Pesticide Formulations

active ingredient (Ai) + inert ingredients

water, emulsifiers, solvents, dry carrier material
stabilizers, dye, surfactants, spreaders, stickers
wetting agents



3.1.2.4 Insecticide Classification (Formulations)

Pesticide Formulations: Spray able Materials

Pesticide Spray Batch

Pesticide Formulation

+

Water or oil

Spray additives=Adjuvants



3.1.2.4 Insecticide Classification (Formulations)

Product Formulations

- Active and Inert Ingredients
- Labels



3.1.2.4 Insecticide Classification (Formulations)

Product Formulations

- Active and Inert Ingredients
- Labels

Bavistin DF

- | | |
|---------------------|------|
| • Active Ingredient | |
| • Carbendazim | 50% |
| • Inert Ingredients | 50% |
| • TOTAL | 100% |

3.1.2.4 Insecticide Classification (Formulations)

Product Formulations

Why Add Inert Ingredients?

1. For ease of pesticide product handling
2. Inerts make measuring and mixing pesticides easier
3. To provide for safety
4. Makes the **Ai** work better
 - Better penetration
 - More selectivity
 - Increased effectiveness



3.1.2.4 Insecticide Classification (Formulations)

Product Formulations

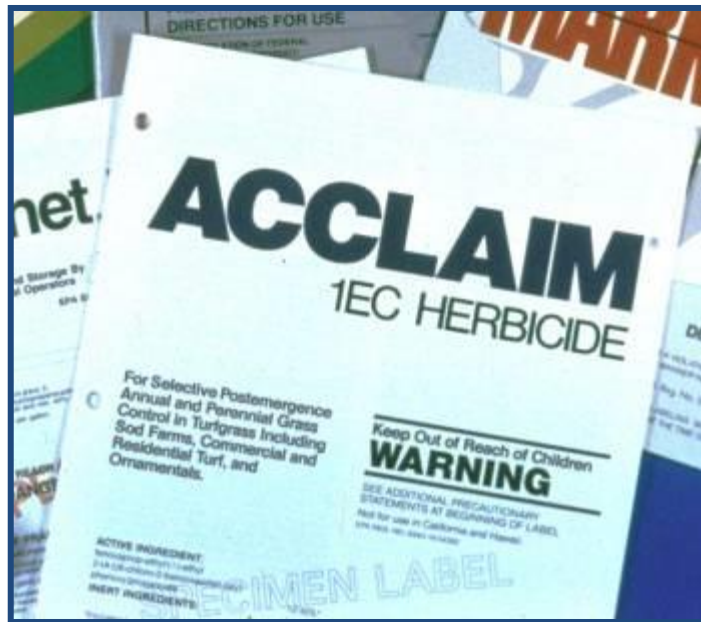
Adjuvant

- The term adjuvant basically means additive
Formulation additive
 - Additive which is sold separately to mix with the product when tank mixing
- Labels will often recommend to add an adjuvant
- Include surfactants, spreaders, wetting agents, colorant dyes, buffers, antifoaming agents, safeners, etc.



3.1.2.4 Insecticide Classification (Formulations)

Product Formulations



1EC

1 % active ingredient
emulsifiable concentrate

80SP

80% active ingredient
by weight
Soluble Powder

40DF

40 % active ingred.
Dry Flowable

3.1.2.4 Insecticide Classification (Formulations)

Product Formulations

Brand Name Abbreviations

- Often brand names include abbreviations that describe something about the formulation

D	– dust	WSP	– water soluble packet
G	– granular	ULV	– ultra low volume
SP	– soluble powder	RTU	– ready to use
SL	– solution	GL	– gel
WP	– wettable powder	LO	– low odor
EC	– emulsifiable concentrate		
DF	– dry flowable		
WDG	– water dispersible granule		

3.1.2.4 Insecticide Classification (Formulations)

Product Formulations

The following formulations will be discussed next

- **EC** Emulsifiable concentrate
- **WP** Wettable powder
- **SL** Soluble (liquid) concentrate
- **GR** Granules
- **DP** Dusts



3.1.2.4 Insecticide Classification (Formulations)

Product Formulations

Emulsifiable Concentrate (E or EC)

Active ingredient (liquid) dissolved in a **petroleum-based solvent** with an **emulsifier** added

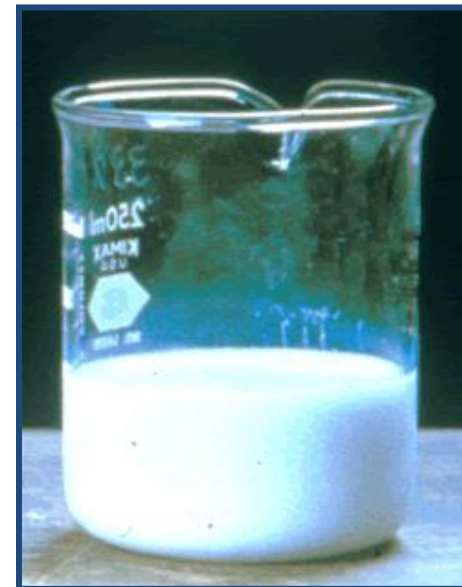
product



Turns
white
when
mixed

Smells of
solvents

diluted



3.1.2.4 Insecticide Classification (Formulations)

Product Formulations

Soluble Liquids (SL)

AI dissolves in liquid carrier; once mixed with water, solutions do not settle out

product

diluted

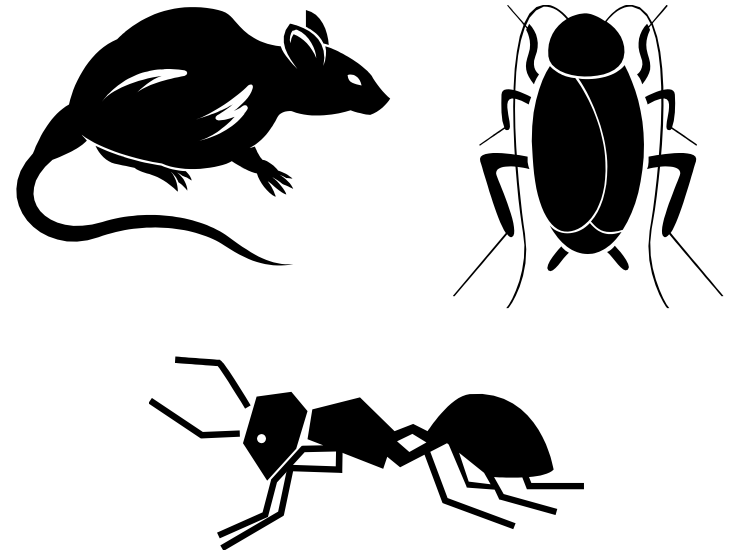


3.1.2.4 Insecticide Classification (Formulations)

Product Formulations

Baits (B)

A bait is an example of a dry or liquid product that is applied without mixing

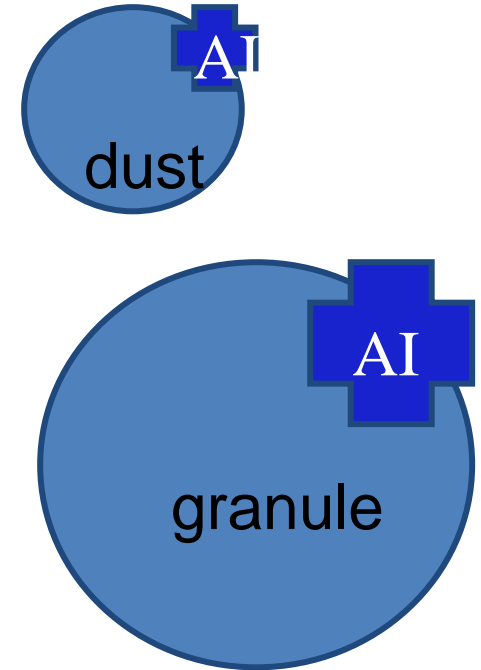


3.1.2.4 Insecticide Classification (Formulations)

Product Formulations

Dusts (D) and Granules (G)

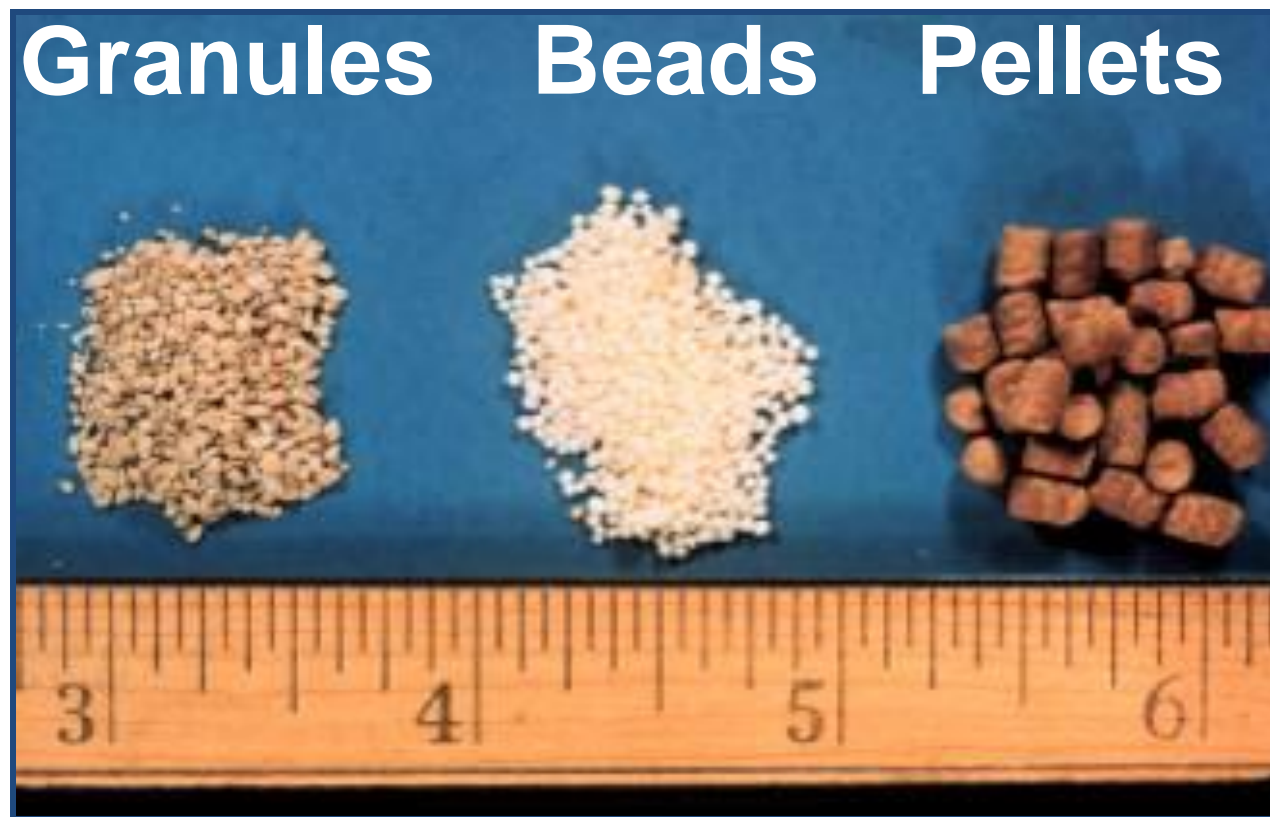
- Ready-to-use
- Can reach hard to get places
- Very little active ingredient
- Very fine, dry inert carrier
- High drift potential
- Distribution and calibration a problem
- Dusts: Irritating to eyes, nose, throat, skin



3.1.2.4 Insecticide Classification (Formulations)

Product Formulations

Granules (G) and Pellets (P or PS)

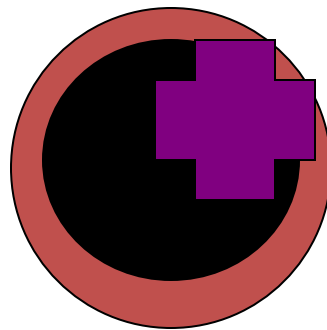


❖ Granules: can be mistaken for food/feed

3.1.2.4 Insecticide Classification (Formulations)

Product Formulations

- Buy Dry --> Mix with water -> Spray
- Wettable Powders (WP)
- Water Dispersible Granules (WDG)
- Dry Flowables (DF)



Active Ingredient (high %)

Dry Carrier

Emulsifier (slick, soapy)

3.1.2.4 Insecticide Classification (Formulations)

Product Formulations

Wettable Powders (WP or W)

Wettable powders settle out quickly, therefore require constant agitation in the spray tank

product

diluted

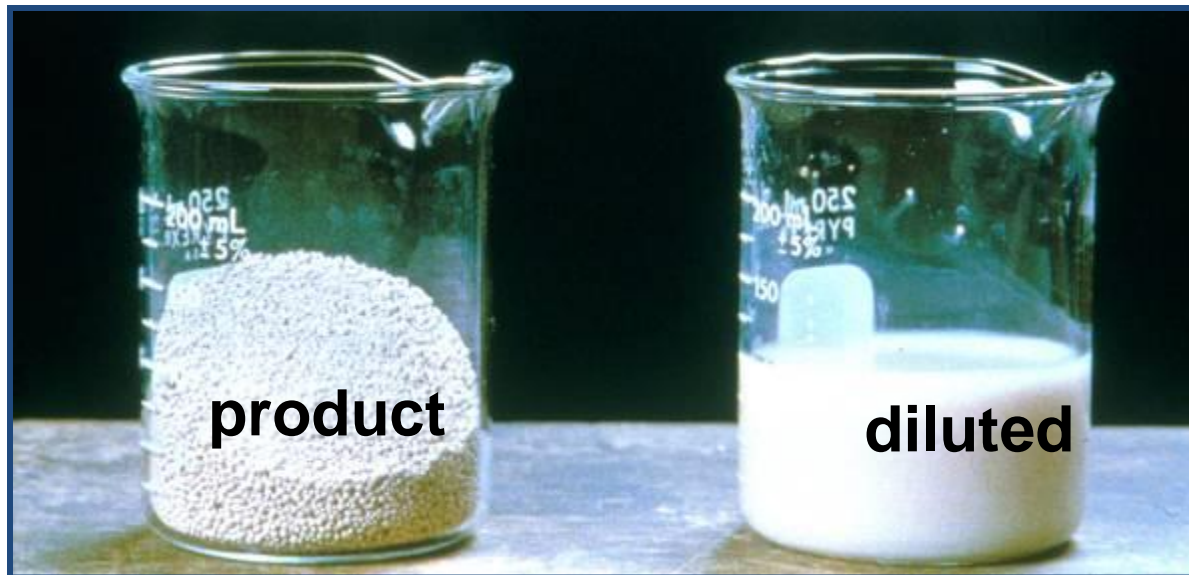


3.1.2.4 Insecticide Classification (Formulations)

Product Formulations

Water-dispersible Granules (WDG) or Dry Flowables (DF)

These materials possess some of the same characteristics as wettable powders except they are formulated into granular-sized particles, so are **easier to handle** with **little inhalation hazard**

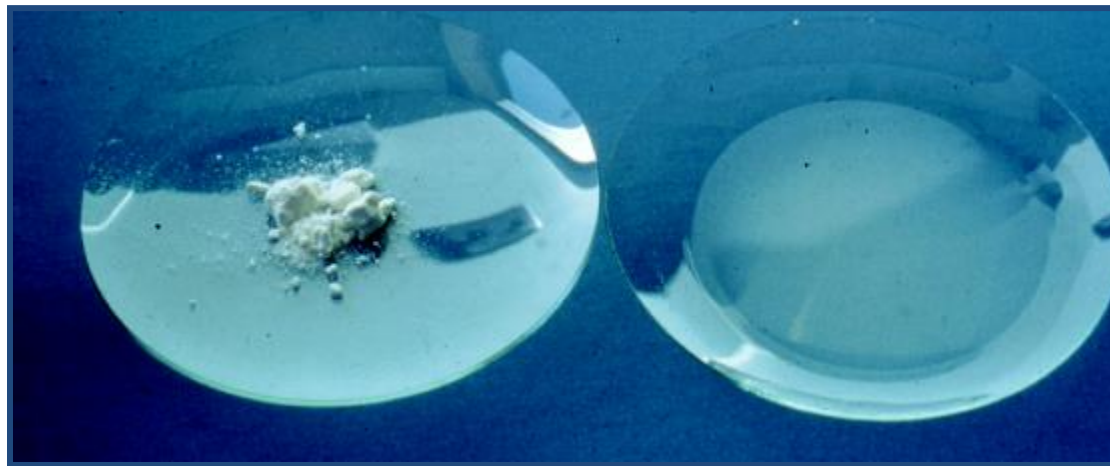


3.1.2.4 Insecticide Classification (Formulations)

Product Formulations

Soluble Powders (SP or WSP)

- Forms true solution, like sugar – no agitation
- Ai is 15-95% by weight
- Few pesticides are soluble powders



3.1.2.4 Insecticide Classification (Formulations)

Product Formulations

Fumigants

- Active as a poisonous gas, penetrates cracks, crevices, and stored commodities
- Highly toxic to all living organisms
- Very high risk of inhalation exposure
- Specialized protection equipment; enclosed space



3.1.2.4 Insecticide Classification (Formulations)

Product Formulations

Adjuvants

purchased additives to add to tank mix or added during formulation process

Surfactants - group

- Wetting agents
- Spreaders
- Emulsifiers
- Stickers/Extenders



Others

- Buffers
- Compatibility agents
- Defoaming agents
- Colorants/dyes
- Safeners
- Thickeners

Buffer Extra Strength™



3.2 Integrated pest management (IPM)

- Also called pest management or Integrated pest management or I.P.M.
- It is the control of insect pests by any combination of control methods result in fewer hazards to man and environment
- Generally, many control methods (natural or artificial) are combined to control a particular insect pest
- All the control measures are the elements of I.P.M.



3.2 Integrated pest management (IPM)

IPM – Integrated Pest Management

The use of all available tactics or strategies to attain an economically acceptable yield or plant quality while causing the least disruption to people, pets and the environment.