

Control of Medically Important Mosquito Vectors

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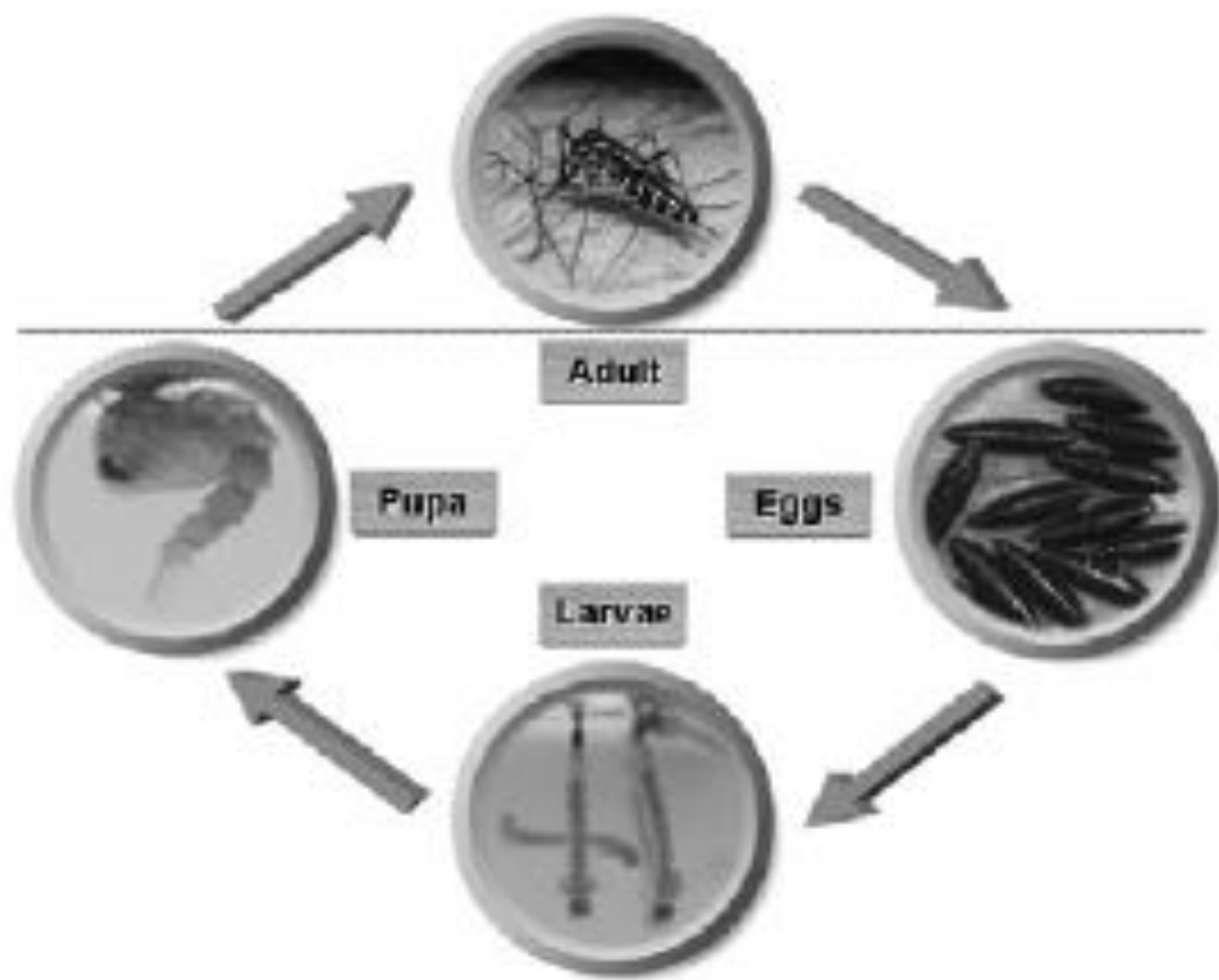
Senior Lecturer

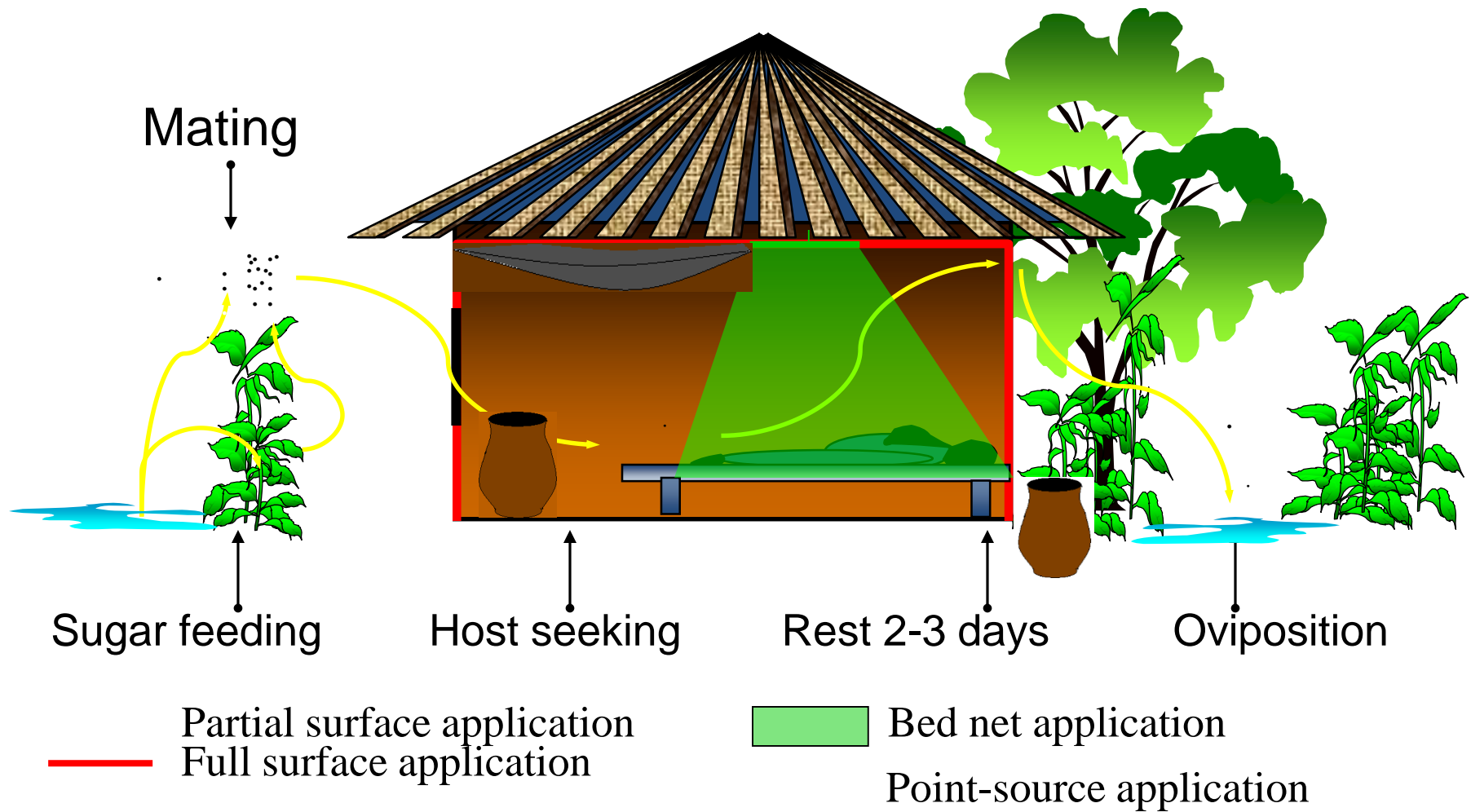
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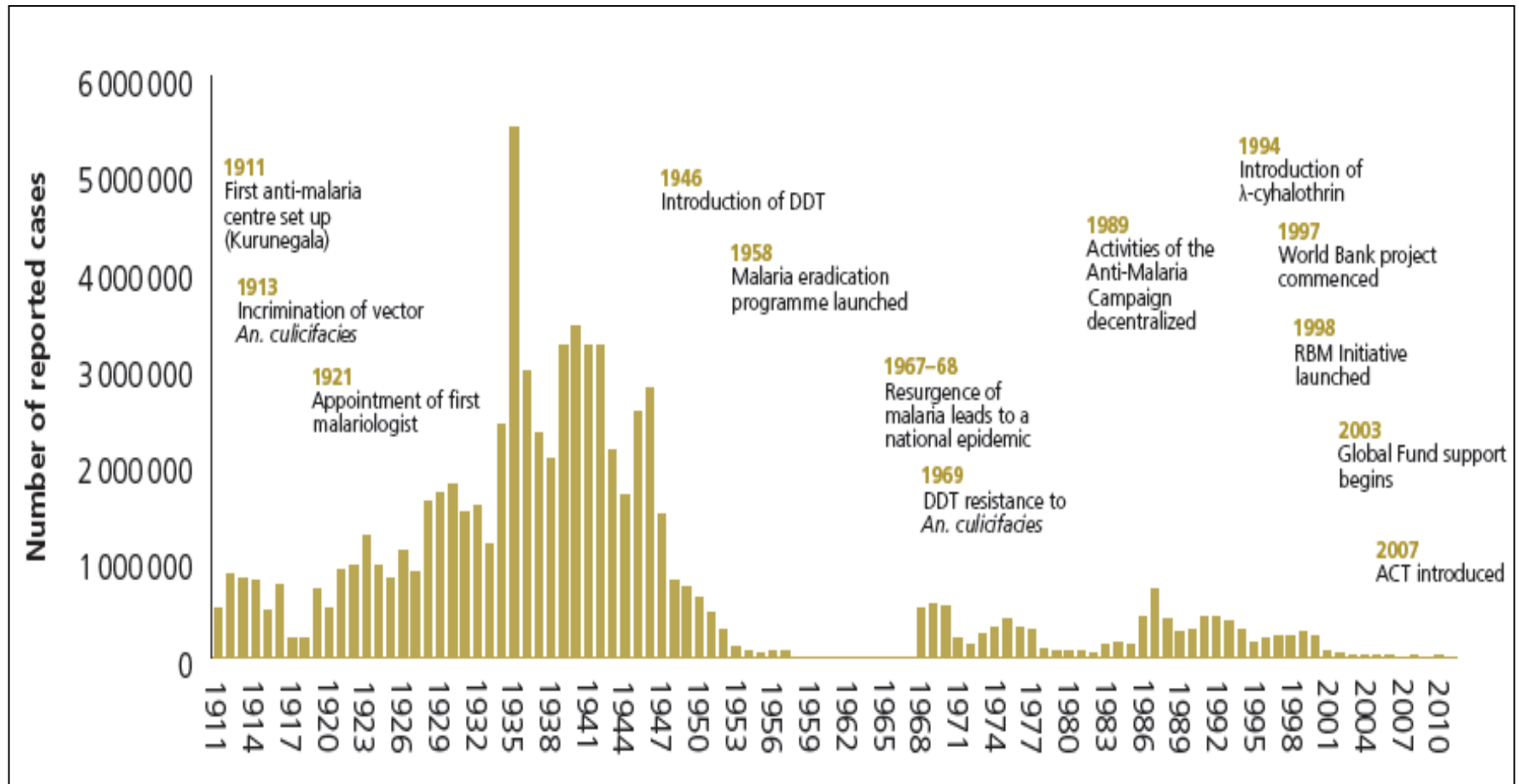
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Mosquito Life Cycle





Timeline of incidence and major events in Sri Lanka's malaria control programme, 1911–2011



Insecticides

- Insecticides can be classified according to their mode of entry to the body.
 - Stomach poisons- Important in agriculture
 - Fumigants- Breathed in
 - Contact poisons- Medically important vectors
 - Desiccants- Drying agents

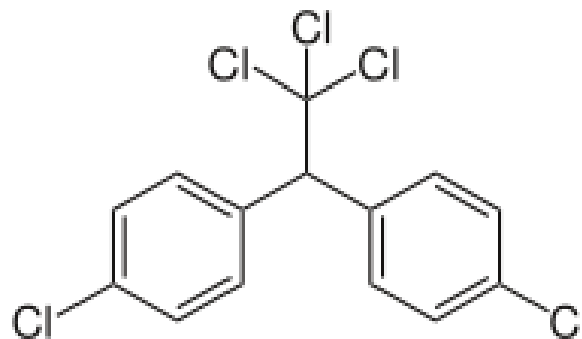
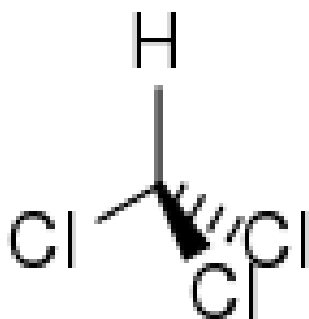
Group of chemicals

- Organochlorine
- Organophosphate
- Carbamate
- Pyrethroid

Organochlorine

- Organic compounds containing at least one covalently bonded atom of chlorine as the dominant functionality.

Examples: DDT, dieldrin, heptachlor, chlordane, methoxychlor.

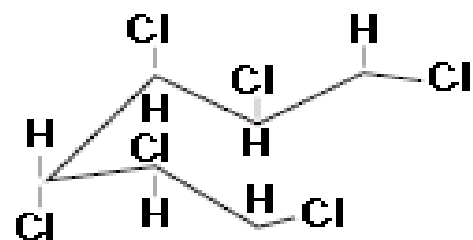


dichlorodiphenyltrichloroethane

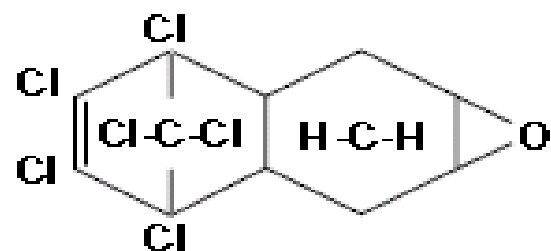
Toxic action

- Organochlorines bind to sodium channels in neurons increasing permeability to sodium.
- This increased permeability facilitates uncoordinated discharge of neurons.
- This uncoordinated discharge can lead to CNS alterations including myoclonus and seizures.

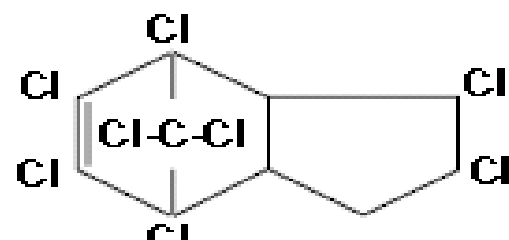
General Chemical Structures



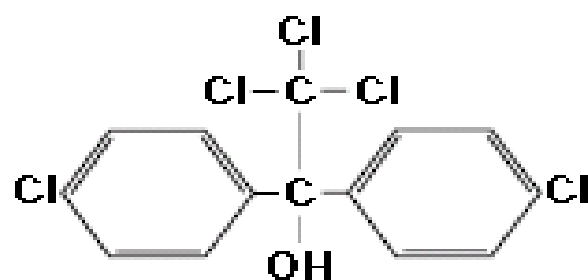
Lindane



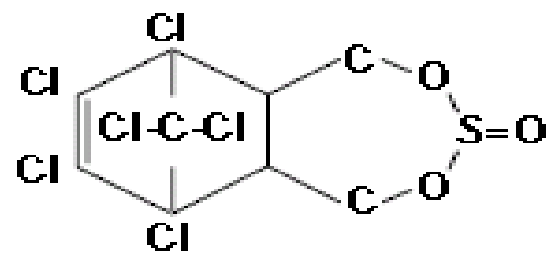
Dieldrin



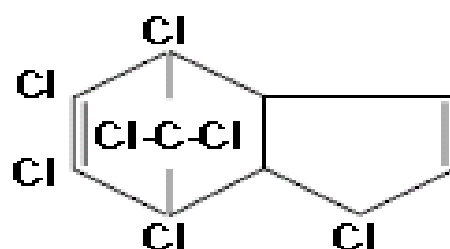
Chlordane



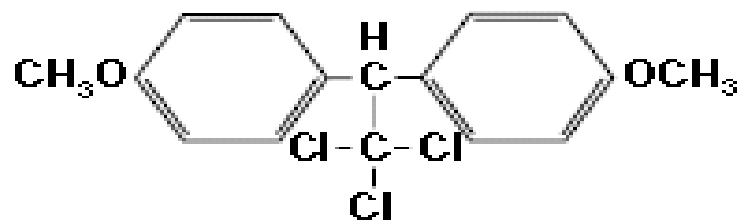
Dicofol



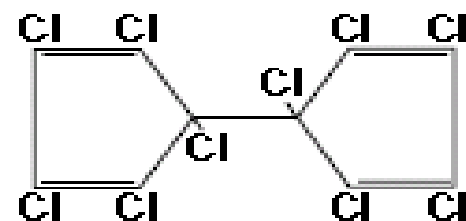
Endosulfan



Heptachlor



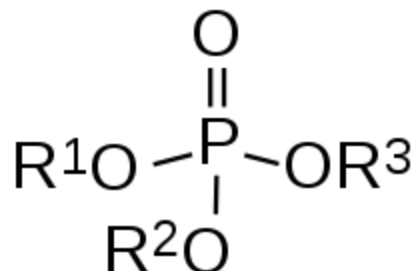
Methoxychlor



Dientochlor

Organophosphate

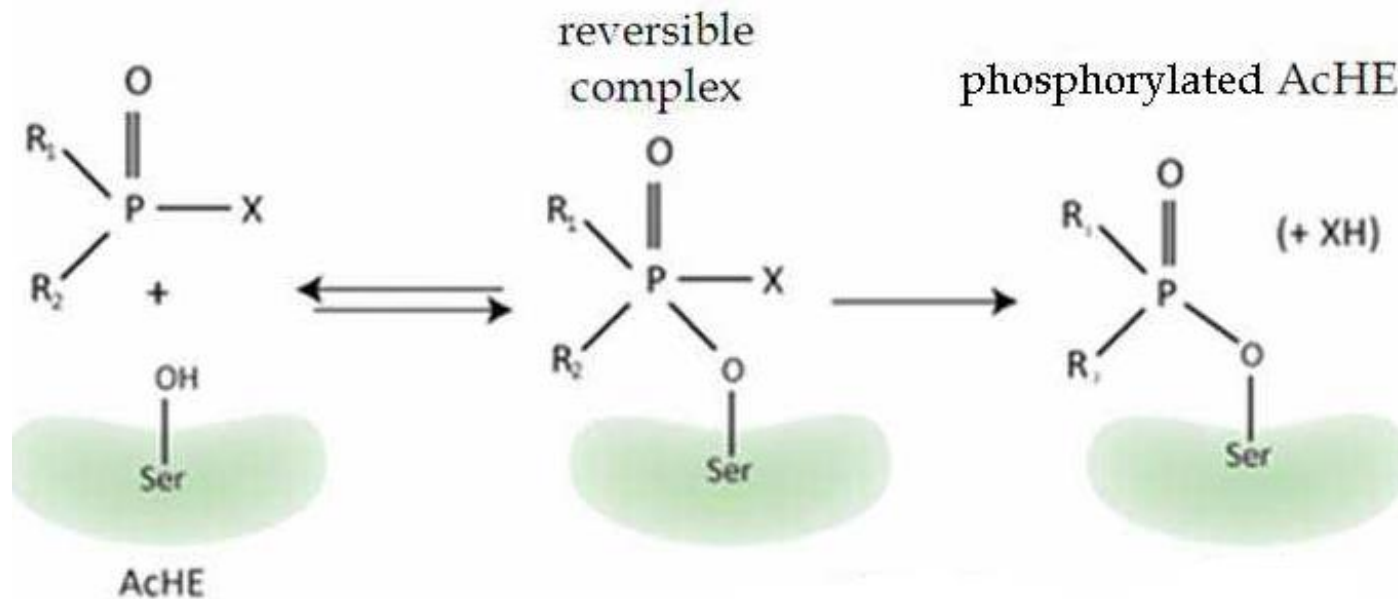
- **Organophosphates** are esters of phosphoric acid.



Mechanism of toxic action – irreversible

- Disrupt the mechanism by which nerves transfer messages to organs.
- Blocking acetylcholinesterase, an enzyme that catalyzes the breakdown of acetylcholine, a neurotransmitter

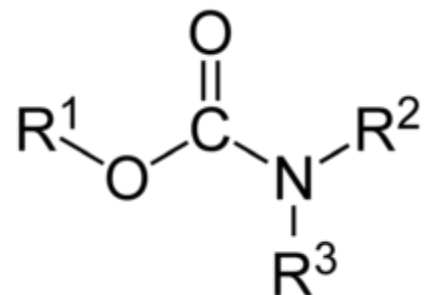
Phosphorylation of hydroxyl group of serine bound in the active centre of AcHE).



Examples:

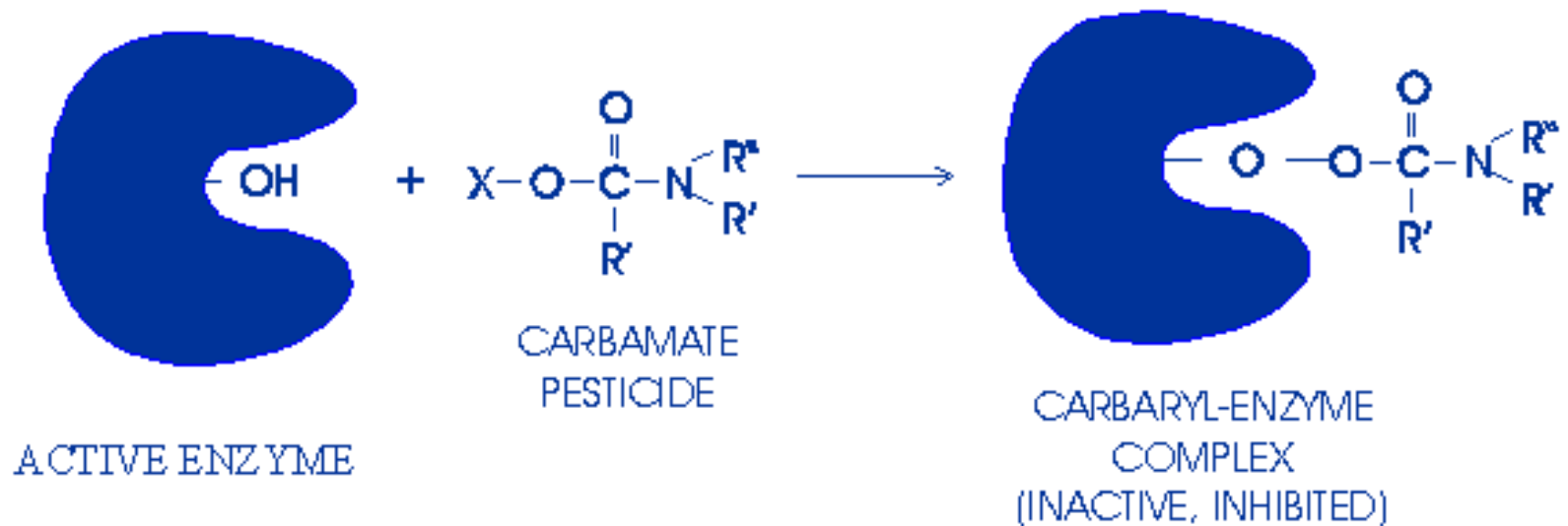
parathion, [malathion](#), [methylparathion](#), [chlorpyrifos](#), [diazinon](#), [dichlorvos](#), [phosmet](#), [fenitrothion](#), [tetrachlorvinphos](#), [azamethiphos](#), and [azinphos-methyl](#).

Carbamate



- A **carbamate** is an organic compound derived from carbamic acid (NH₂COOH)- Amines.
- Aldicarb
- Carbofuran
- Carbaryl
- Ethienocarb
- Fenobucarb
- Oxamyl
- methomyl

- Mechanism of the toxic action – reversible inhibition of acetylcholinesterase (by carboxylation of hydroxyl group of serine bound in the active centre of AcHE).



Pyrethroid

Pyrethroid is an organic compound similar to the natural [pyrethrins](#) produced by the flowers of pyrethrums.

Cyfluthrin

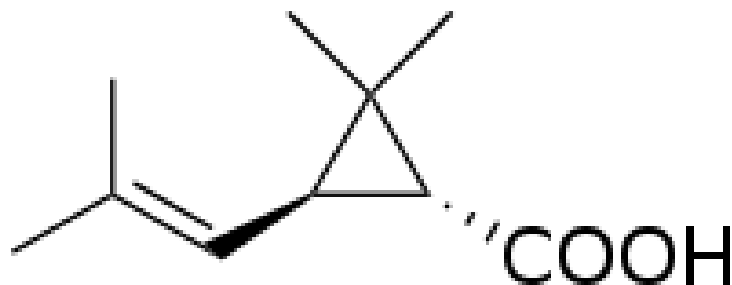
Cypermethrin

Deltamethrin

Etofenprox

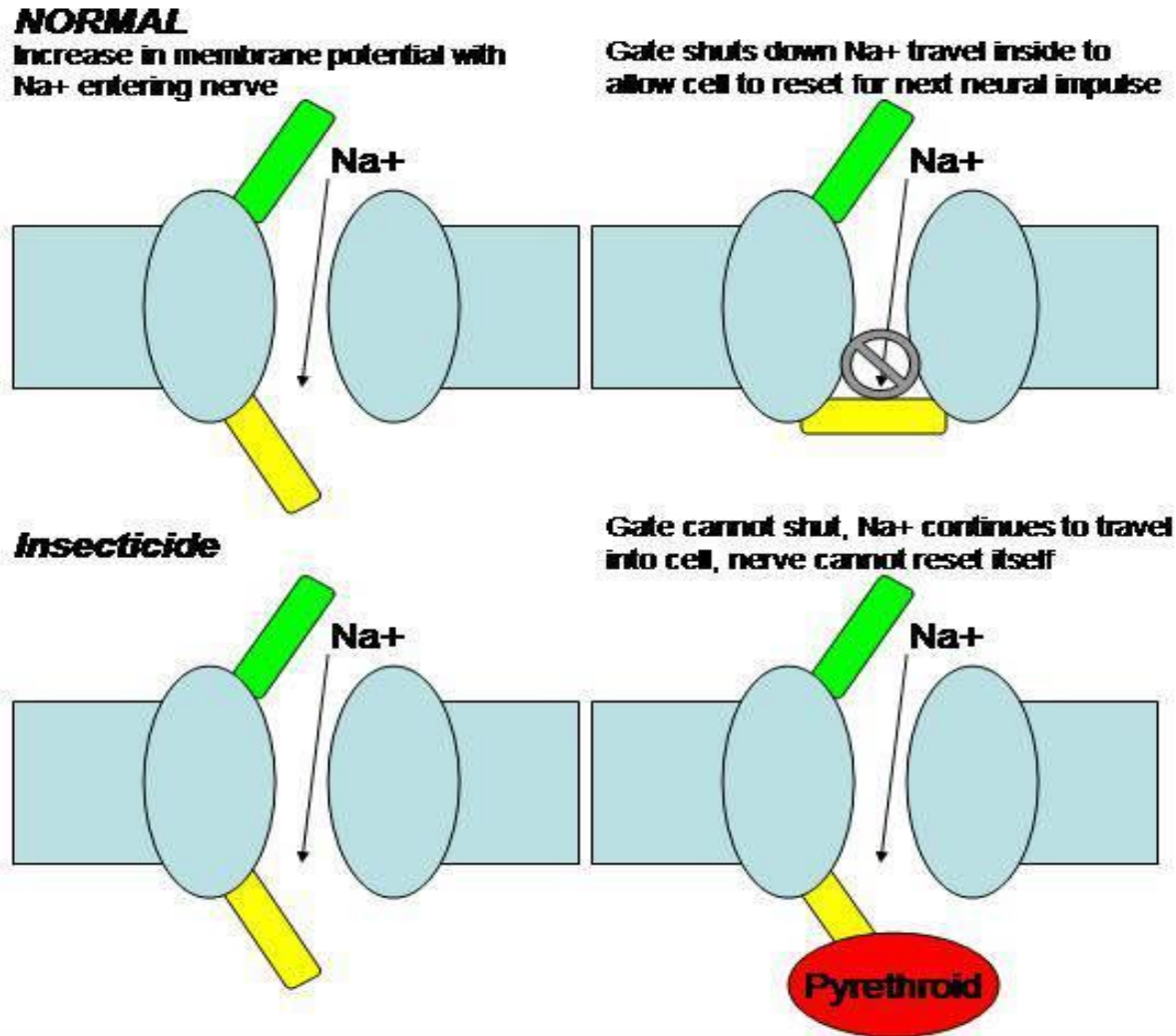
Permethrin

Lambda-cyhaothrin



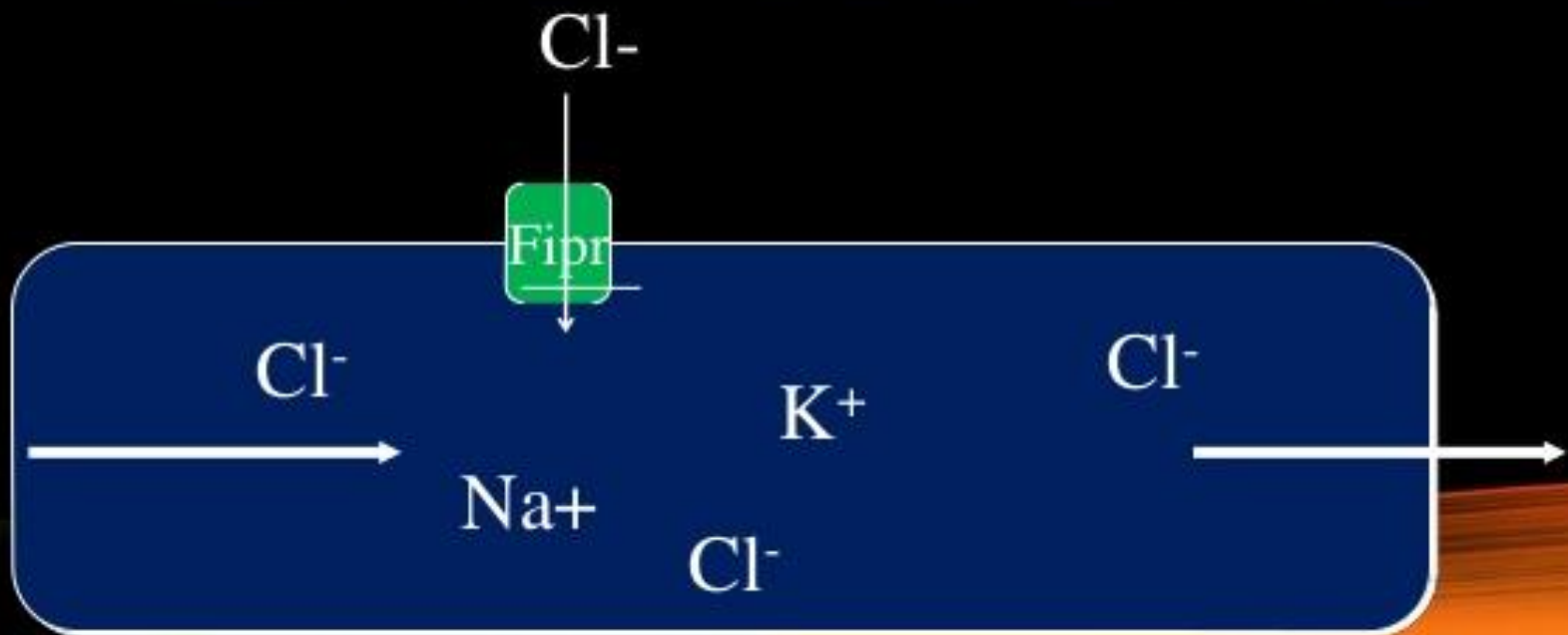
Mechanism of the toxic action

Reversible block of sodium channels and inhibition of GABA



Mode Of Action

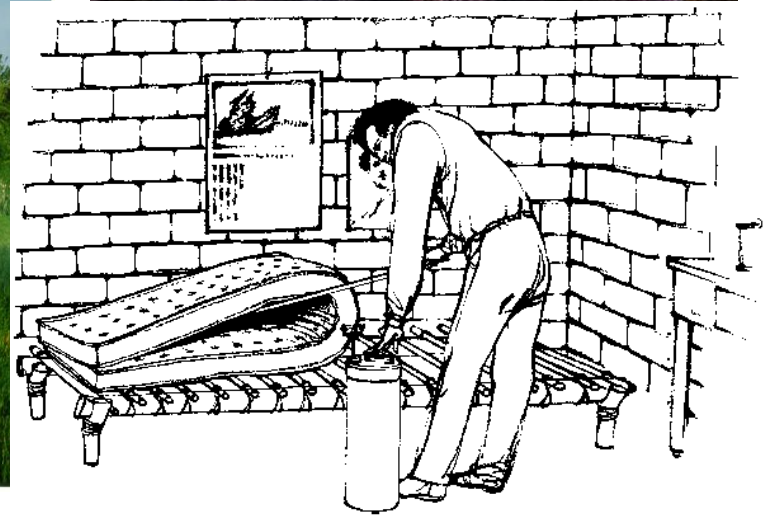
- ❖ Acts as an inhibitor at the γ -aminobutyric acid (GABA) receptor as a non-competitive blocker of the GABA-gated chloride channel (similar to lindane and cyclodienes)
- ❖ Chemical and biological activation producing equally toxic and sometime more persistent metabolites with same mode of action



Antagonist at GABA-gated Chloride Channel

Control Directed at the Adult Stages

- Personal protection
- Aerosols, Mists and Fogs
- Ultra-low-volume applications
- Residual house-spraying



Personal protection

- Screening windows, doors and ventilators
 - 6-8 meshes/cm.
- Use of mosquito nets
 - Normal or impregnated with pyrethroids
- Spraying bedrooms early in the evening with pyrethrum using small sprayers.
- Mosquito coils impregnated with pyrethroids.
- Vapourizing mats.
- Insect repellents (Anoints or soap)
 - Diethyltoluamide (Deet)
 - N,N-diethylphenylacetamide (Depa)
 - Dimethylphthalate (Dimp)
 - Citronella oil

6-10 hours

- Insecticide impregnated clothing.



Impregnated Net Material



Aerosols, mists and fogs

- Can be used to kill outdoor resting (exophilic) adults using hand-held or vehicle-mounted machines.
- Machines generate insecticidal mist (51-100), aerosols (<50) or fog (<15).
- Indoor resting (endophilic) adults may occasionally kill.
 - Malathion
 - Bendiocarb (Ficam)
 - Fenitrothion (Sumithion)
 - Pirimiphos methyl (Actellic)
 - Synthetic pyrethroids.

- Effective to perform in the early morning or evening.



Ultra- low-volume applications

- The ULV techniques apply the minimum of insecticide (<5 L /ha).
- Trucks or aircraft can spray much larger areas on a tank of insecticides (Aerial or ground-based).
 - Malathion
 - Pirimiphos methyl (Actellic)
 - Fenitrothion (Sumithion)
 - Propoxur (Baygon)
 - Chlorpyrifos (Dursban)
 - Pyrethroids.

- Effective to reduce outdoor resting and biting mosquitoes in epidemic or emergency situations.



Residual house-spraying

- Some mosquitoes such as malaria and filariasis vectors rest in houses before or after blood feeding.
- Population can be reduced by insecticidal spraying of houses.



Control

Directed at the Immature Stages

- Biological Control
 - Predators
 - Pathogens and Parasites
 - Genetic Control
- Mechanical (Environmental) Control
 - Source Reduction
 - Environmental Manipulation
- Chemical Control
 - Oils
 - Paris Green
 - Insecticides
 - Insect Growth Regulators (IGRs)



Chemical control

- Most control approaches use larvicides except malaria vectors.

Oils

Spraying mineral oils onto water surface of breeding places.

Paris Green

Apply fine dust of Paris Green (Copper acetoarsenite).

When ingested by surface feeding larval stages, it acts as a stomach poison.

Introduce as pellet or granule forms for bottom feeders.

Insecticides

With arrival of residual insecticides (ex- DDT) in mid 1940s the use of oils and Paris Green abandoned.

However, because of their persistence in the environment and accumulation in food chains DDT and other organochlorines should not use as larvicides.

Less persistent and biodegradable insecticides should be used (Organophosphates and Carbamates).

Recommended chemicals for larviciding

Organophosphates

- Malathion
- Pirimiphos methyl (Actellic)
- Fenitrothion (Sumithion)
- Tempos (Abate)

Carbamates

- Propoxur (Baygon)

Pyrethroids

- Permethrin *
- Deltamethrin *

Use only in special cases

* Toxic to other aquatic organisms.

- Temephos (Abate) has very low mammalian toxicity.
- Granules or microencapsulated formulations which slowly release the insecticide over days or even weeks in potable water to control *Aedes* vectors.

Mansonia larvae can be killed by spraying herbicides.

- Diquat
- 2,4-D.

How do you apply larvicides ?

Apply as emulsions, oils, granules or pellets.

Granules (0.25-0.6 mm) and pellets (0.6-2 mm) are better for penetrating dense growth of aquatic vegetation.

Insecticides formulated as slow-release granules/ pellets can be scattered over marshy lands during dry seasons.

Insect Growth Regulators (IGRs)

- These chemicals inhibit chitin formation of the immature stages and arrest larval development.
- Environmental friendly because they are more or less specific in killing mosquitoes.
- Extremely low toxicity to humans.
- Relatively high cost.
 - Methoprene (Altosid)
 - Pyriproxyfen
 - Diflubenzuron

Assignment 1- Update followings

Disease		Bionomic status of vectors				
	Name of the vector/s	Feeding behavior	Feeding habitat	Resting habitat	Active during?	Breeding habitat
Malaria						
Filariasis						
JE						
Dengue						

List appropriate control strategies for following control programs

- Malaria
- Filariasis- Urban
- Dengue



Thank You

