Neonicotinoids and their Impact on Ecosystem Services for Agriculture and Biodiversity in Africa

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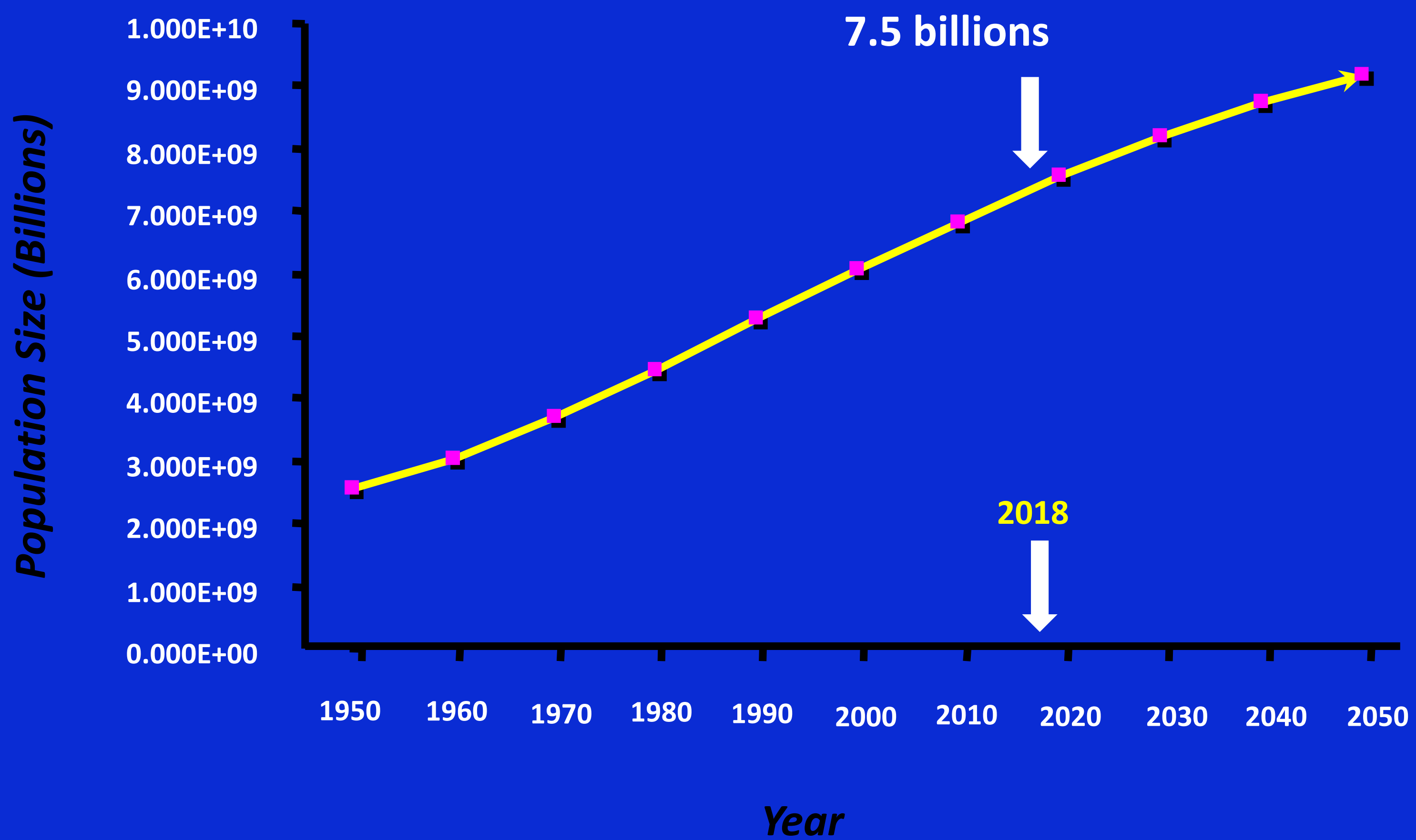
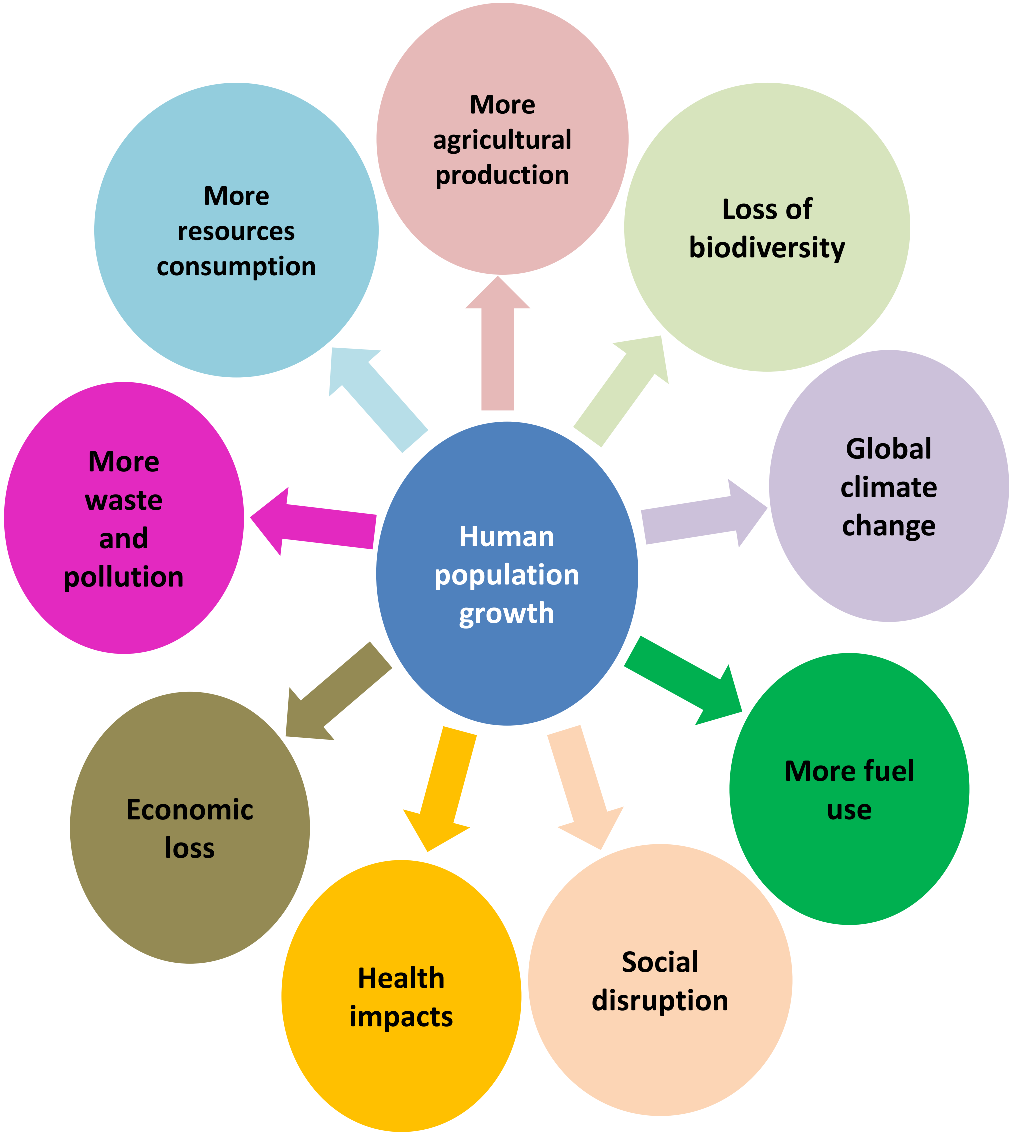
We live in a tragic world not ONLY politically but also suffering from the current economic crisis !

World Population Growth 1950 - 2050

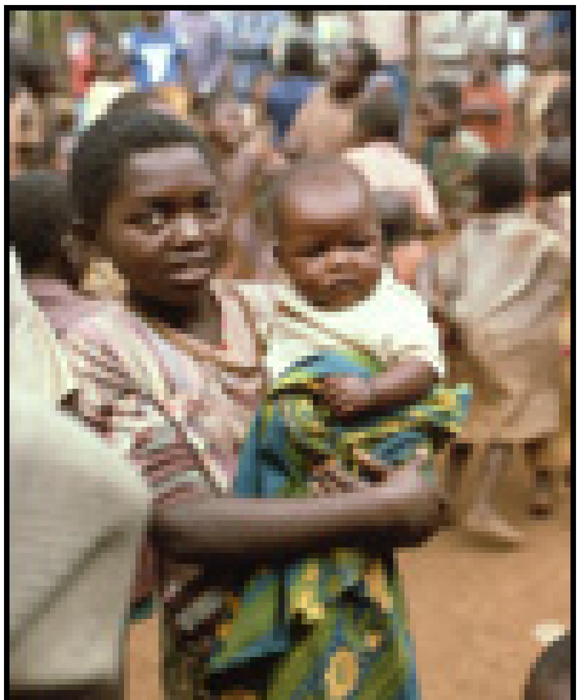


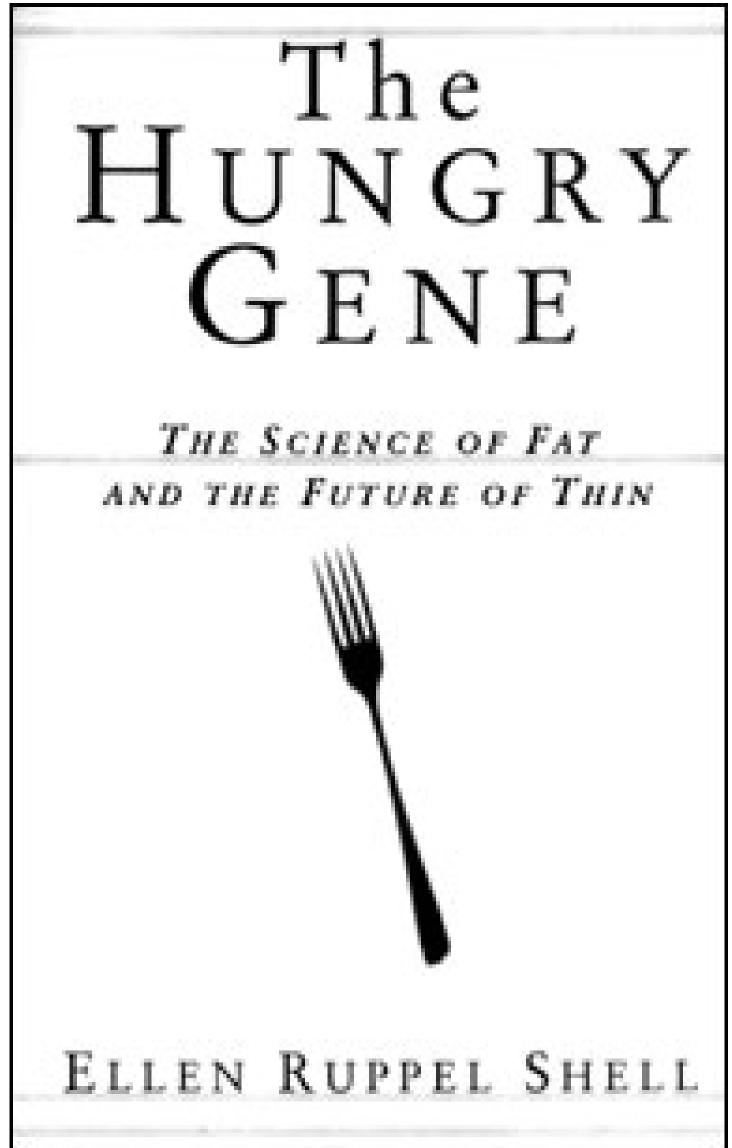
http://www.census.gov/ipc/www/worldpop.html

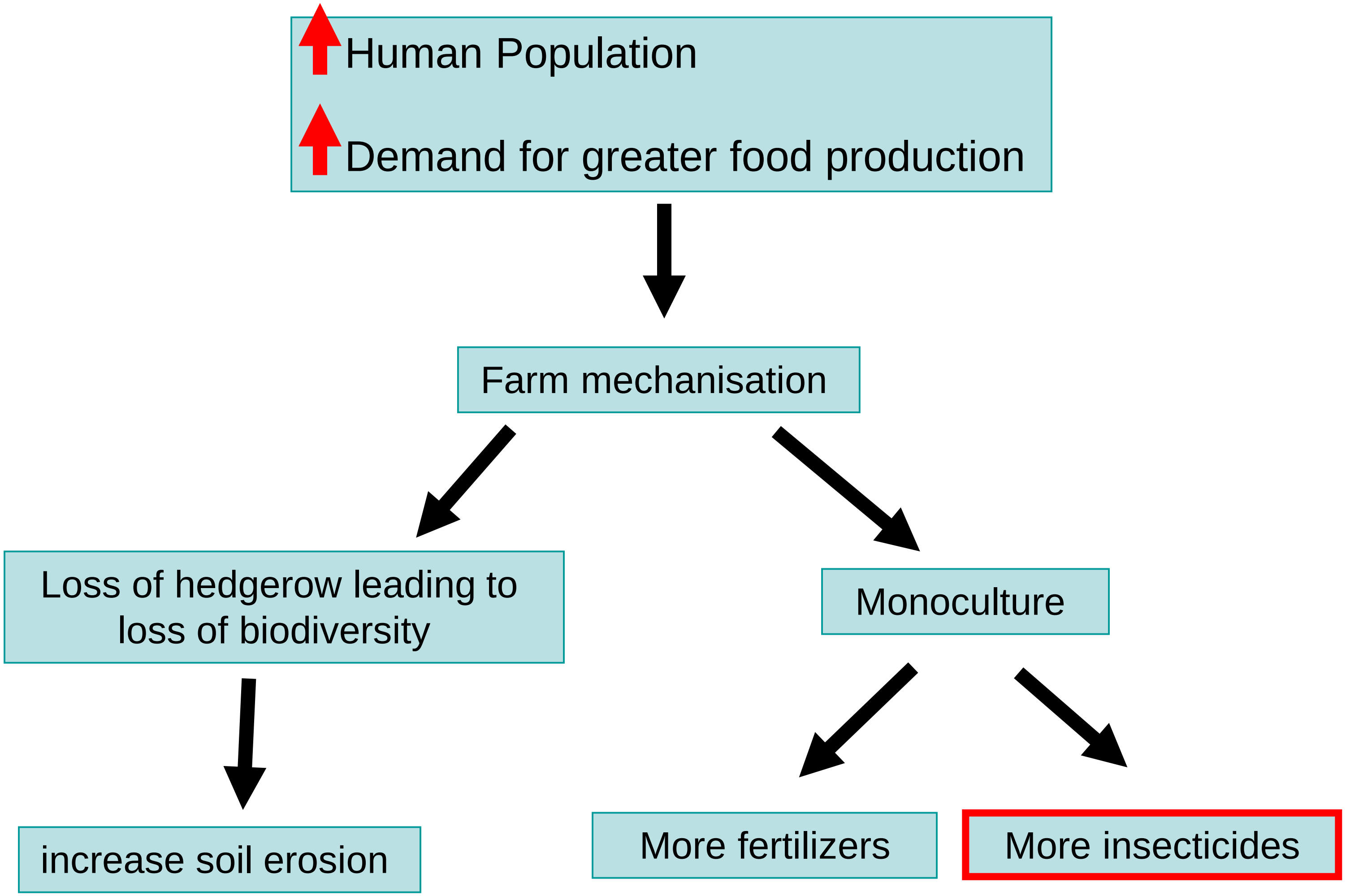
Consequences of population growth



Depletion of natural resources




The
HUNGRY
GENE
THE SCIENCE OF FAT
AND THE FUTURE OF THIN
ELLEN RUPPEL SHELL

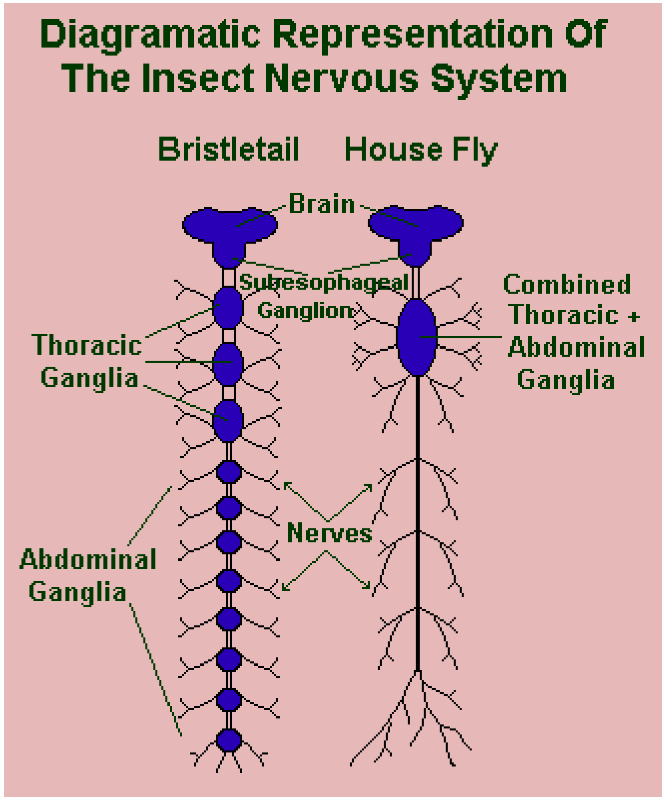

Human Population
Demand for greater food production
Farm mechanisation
Loss of hedgerow leading to loss of biodiversity
Monoculture
increase soil erosion
More fertilizers
More insecticides

What about today`s insecticides?

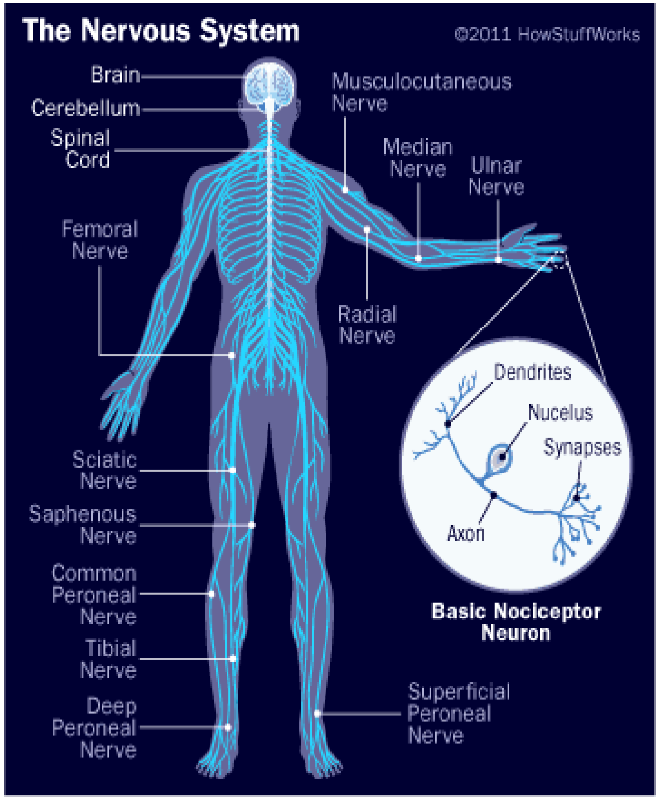
Insecticide Classes	Examples	Mode of action
Cyclodiene	Aldrin	Nervous system
Organophosphorous	Chlorpyrifos	Nervous system
Carbamates	Propoxur	Nervous system
Pyrethroids	Permethrin	Nervous system
Fumigant (inorganic)	Sulfluryl Fluoride	Energy production
Juvenile hormone mimic	Fenoxycarb	Endocrine system

Neurotoxins can act on the Nerve systems

Insect



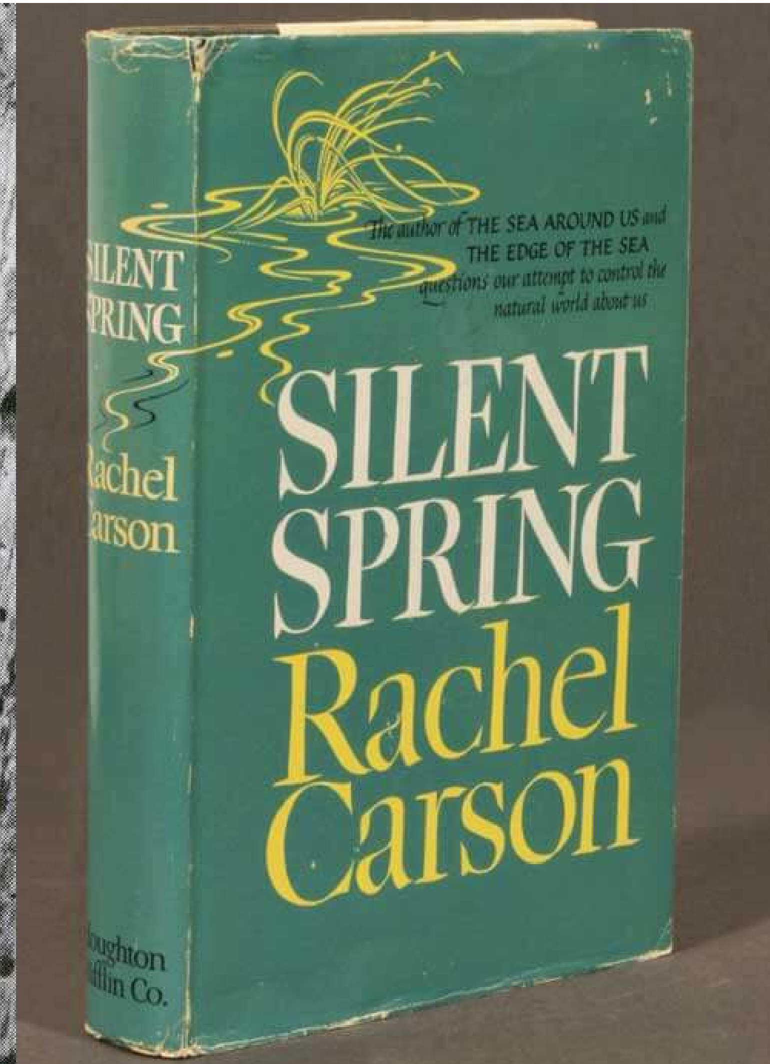
Human



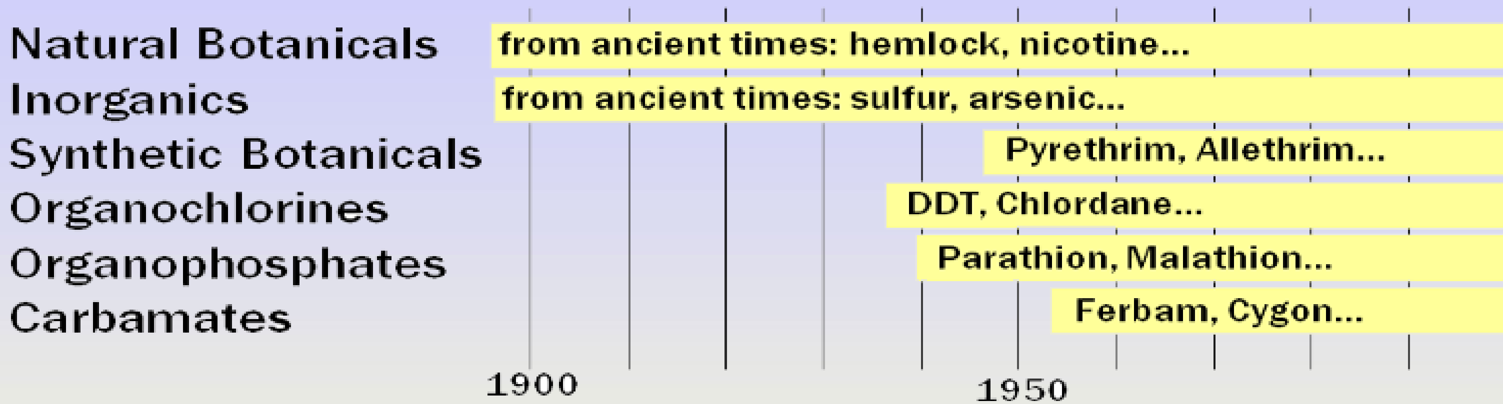
Neurotoxins Insecticides

We need Clean Environment free of insecticides !!

A BOOK THAT CHANGED
THE WORLD (1962)



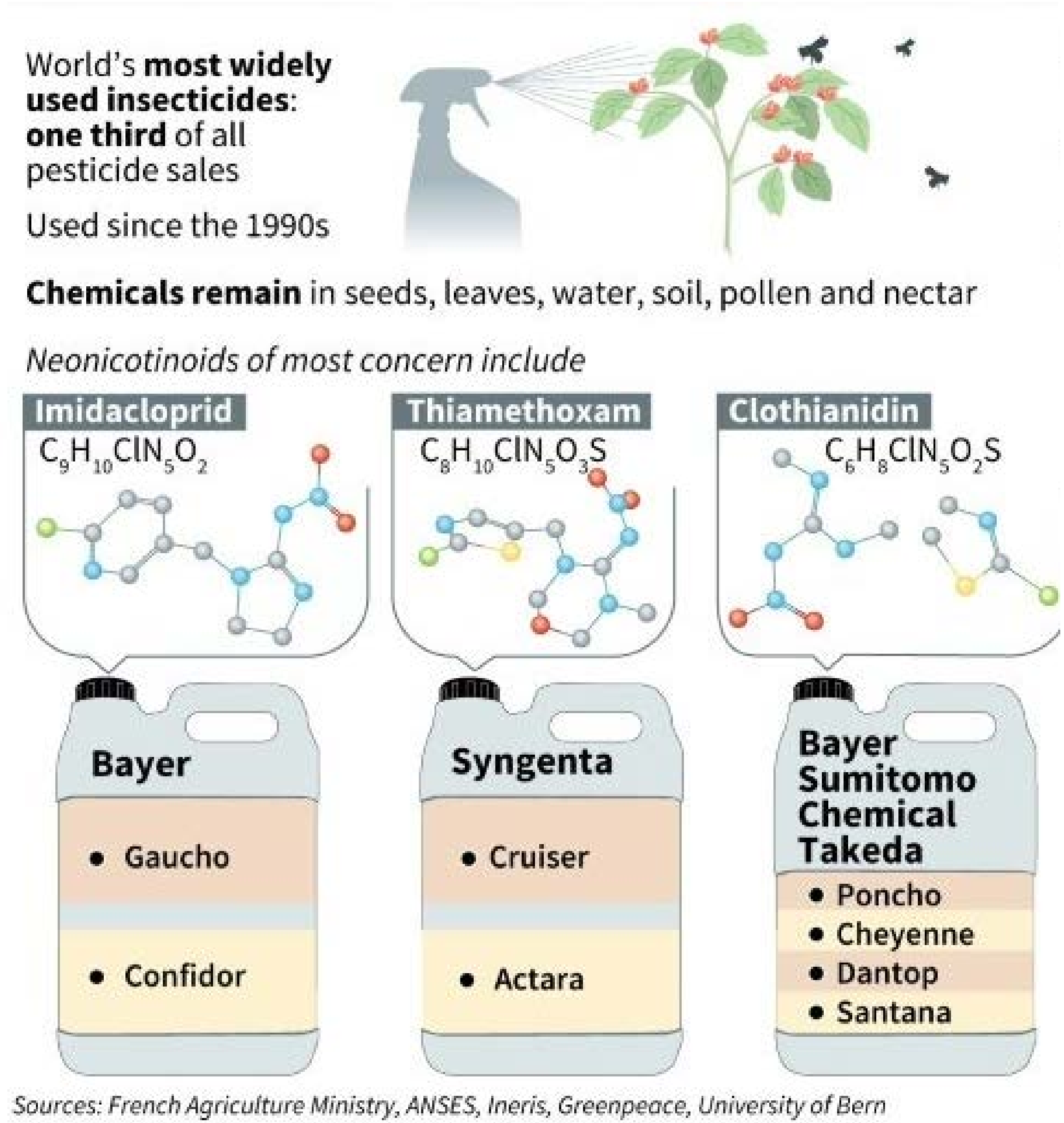
History of insecticides

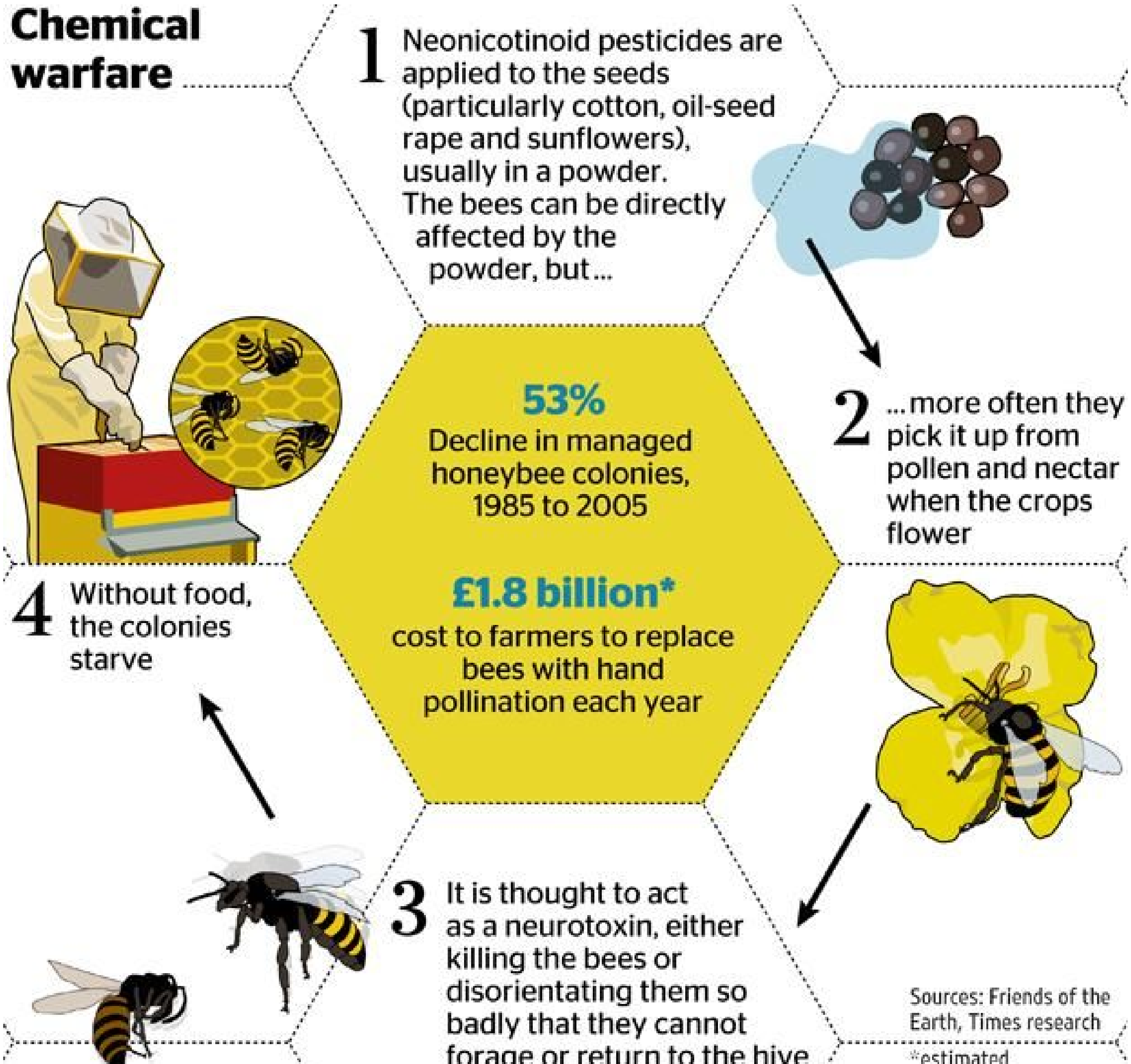


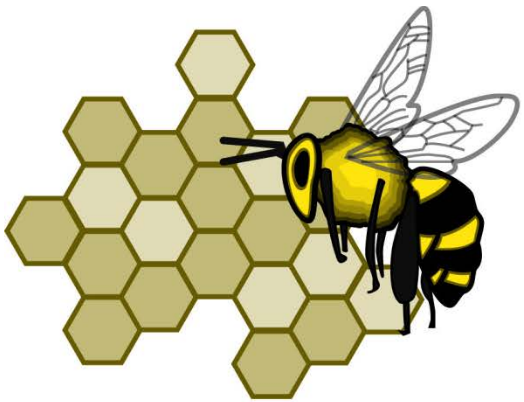
Other Milestones

1750	Modern Chemistry
1830	Organic Chemistry
1914-18	World War I
1939-45	World War II
1962	*Silent Spring* published
1963-73	Vietnam War (Agent Orange)
1970	EPA created
1972	DDT withdrawn

Neonicotinoid Insecticides:




Chemical warfare
1 Neonicotinoid pesticides are applied to the seeds (particularly cotton, oil-seed rape and sunflowers), usually in a powder. The bees can be directly affected by the powder, but...
2 ...more often they pick it up from pollen and nectar when the crops flower
3 It is thought to act as a neurotoxin, either killing the bees or disorientating them so badly that they cannot forage or return to the hive
4 Without food, the colonies starve
53%
Decline in managed honeybee colonies, 1985 to 2005
£1.8 billion*
cost to farmers to replace bees with hand pollination each year
Sources: Friends of the Earth, Times research
*estimated



colony collapse disorder

(CCD)

→

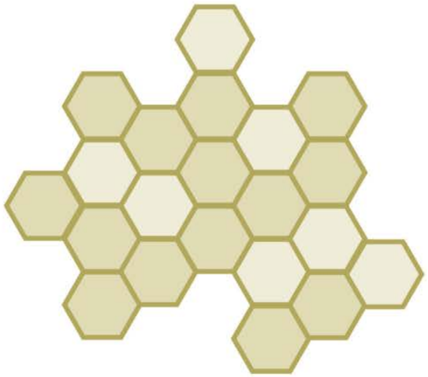
2-4 weeks

possible causes:

pesticides

pathogens

nutritional stress?



healthy hive:

- balanced population with strict division of labor
- plenty of food stores of wax and honey

unhealthy hive:

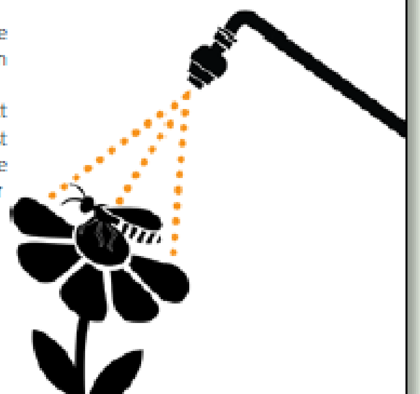
- no adult bees (dead or alive), but larval brood present
- decreased foraging efficiency and survival

Neonicotinoids Exposure pathways to bees?

Direct Contact

occurs when pesticide sprays directly land on bees.

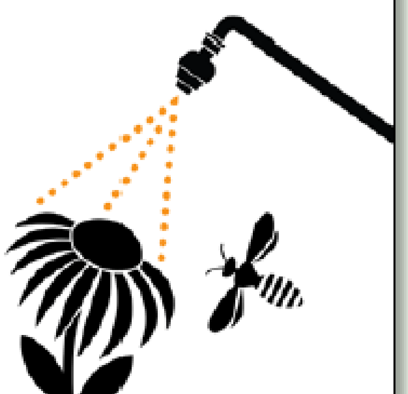
The risk of direct contact is highest when chemicals are sprayed on or near blooming crops, weeds, cover crops, or habitat areas.



Residue Contact

occurs when bees visit flowers or walk on leaves that have been previously treated with pesticides.

The risk of residue contact is especially problematic with chemicals with a long half-life.



Dose For Dose, Neonicotinoids Are More Toxic For Bees Than DDT:

E.g.
Clothianidine & Deltamethrine are almost 10,800 times more toxic
Imidaclopride is 7,297 times more toxic.....

RELATIVE TOXICITY FOR BEES, OF SOME COMMONLY USED CROP-PESTICIDES, 1945 - 2014

Pesticides : toxicity / bees (LD_{50} ng/bee)

pesticide	®	Use	Dose g/ha	LD50 ng/ab	Tox/DDT
DDT	Dinocide	insecticide	200-600	27 000.0	1
thiaclopride	Proteus	insecticide	62,5	12 600.0	2.1
amitraze	Apivar	acaricide	-	12 000.0	2.3
acetamiprid	Supreme	insecticide	30-150	7 100.0	3.8
coumaphos	Perizin	acaricide	-	3 000.0	9
methiocarb	Mesurol	insecticide	150-2200	230.0	117
tau-fluvalinate	Apistan	acaricide	-	200.0	135
carbofuran	Curater	insecticide	600	160.0	169
λ-cyhalothrine	Karate	insecticide	150	38.0	711
thiaméthoxam	Cruiser	insecticide	69	5.0	5 400
fipronil	Regent	insecticide	50	4.2	6 475
imidaclopride	Gaucho	insecticide	75	3.7	7 297
clothianidine	Poncho	insecticide	50	2.5	10 800
deltamethrine	Décis	insecticide	7,5	2.5	10 800

REF: **Dr BONMATIN Jean-Marc**, Centre National de la Recherche Scientifique, France

More Info: www.buzzaboutbees.net/Neonicotinoids-And-Bees.html

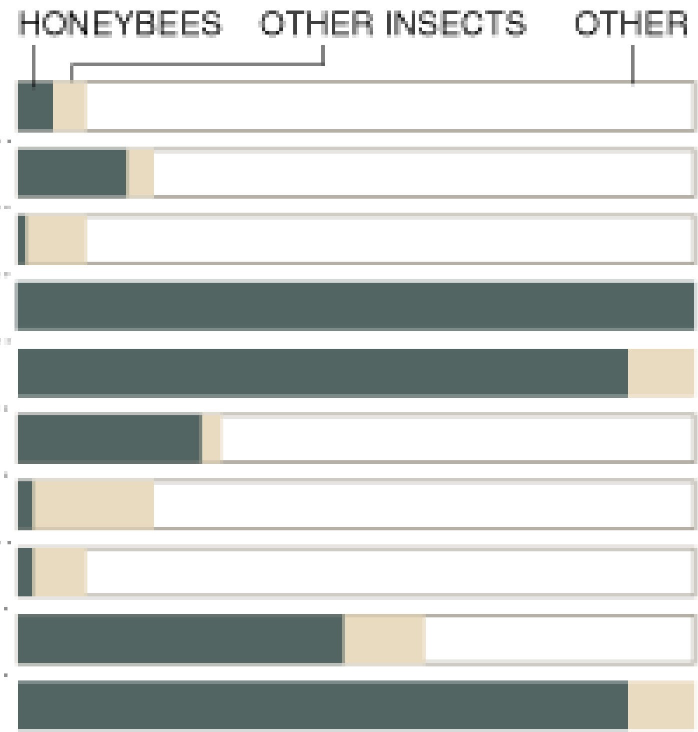
NOT only for honey

Relying on Bees

Some of the most valuable fruits, vegetables, nuts and field crops depend on insect pollinators, particularly honeybees.

	Crop value *in billions 2006*	Percentage pollinated by honeybees
Soybeans	$19.7	5%
Cotton	5.2	16
Grapes	3.2	1
Almonds	2.2	100
Apples	2.1	90
Oranges	1.8	27
Strawberries	1.5	2
Peanuts	0.6	2
Peaches	0.5	48
Blueberries *cultivated*	0.5	90

Percentage of crop pollinated by . . .



Besides insects, other means of pollination include birds, wind and rainwater.

Sources: United States Department of Agriculture; Roger A. Morse and Nicholas W. Calderone, Cornell University

The New York Times


I DIE
YOU DIE.

Neonicotinoid insecticides: blamed for bee decline

World's **most widely used insecticides**: **one third** of all pesticide sales

Used since the 1990s

Chemicals remain in seeds, leaves, water, soil, pollen and nectar

- **Neuro-active**. Based on the chemical structure of **nicotine**
- **Attacks** the bee's **nervous system**, leading to **paralysis and death**
- Accused of lowering bee **fertility and resistance to disease**

Neonicotinoids of most concern include

Imidacloprid

$C_9H_{10}ClN_5O_2$

Bayer

- Gaucho
- Confidor

Thiamethoxam

$C_8H_{10}ClN_5O_3S$

Syngenta

- Cruiser
- Actara

Clothianidin

$C_6H_8ClN_5O_2S$

Bayer Sumitomo Chemical Takeda

- Poncho
- Cheyenne
- Dantop
- Santana

European Union law

To be banned in fields effective Dec 19, 2018

imidacloprid
thiamethoxam
clothianidin

(Use allowed in greenhouses)

Sources: French Agriculture Ministry, ANSES, Ineris, Greenpeace, University of Bern

www.nature.com/scientificreports

SCIENTIFIC REPORTS

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Neonicotinoid-induced impairment of odour coding in the honeybee

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Exposure to neonicotinoid pesticides is considered one of the possible causes of honeybee (*Apis mellifera*) population decline. At sublethal doses, these chemicals have been shown to negatively affect a number of behaviours, including performance of olfactory learning and memory, due to their interference with acetylcholine signalling in the mushroom bodies. Here we provide evidence that neonicotinoids can affect odour coding upstream of the mushroom bodies, in the first odour processing centres of the honeybee brain, *i.e.* the antennal lobes (ALs). In particular, we investigated the effects of imidacloprid, the most common neonicotinoid, in the AL glomeruli via *in vivo* two-photon calcium imaging combined with pulsed odour stimulation. Following acute imidacloprid treatment, odour-evoked calcium response amplitude in single glomeruli decreases, and at the network level the representations of different odours are no longer separated. This demonstrates that, under neonicotinoid influence, olfactory information might reach the mushroom bodies in a form that is already incorrect. Thus, some of the impairments in olfactory learning and memory caused by neonicotinoids could, in fact, arise from the disruption in odor coding and olfactory discrimination ability of the honey bees.

Is there is alternative way to control insect pests ?

Insect Senses

- Vision
- Hearing
- Smell and Taste

"Olfaction Research"

Olfaction Research: A new strategy for controlling insect pests

F smell

Sense

Chemical signals are important cues for insect behavior:

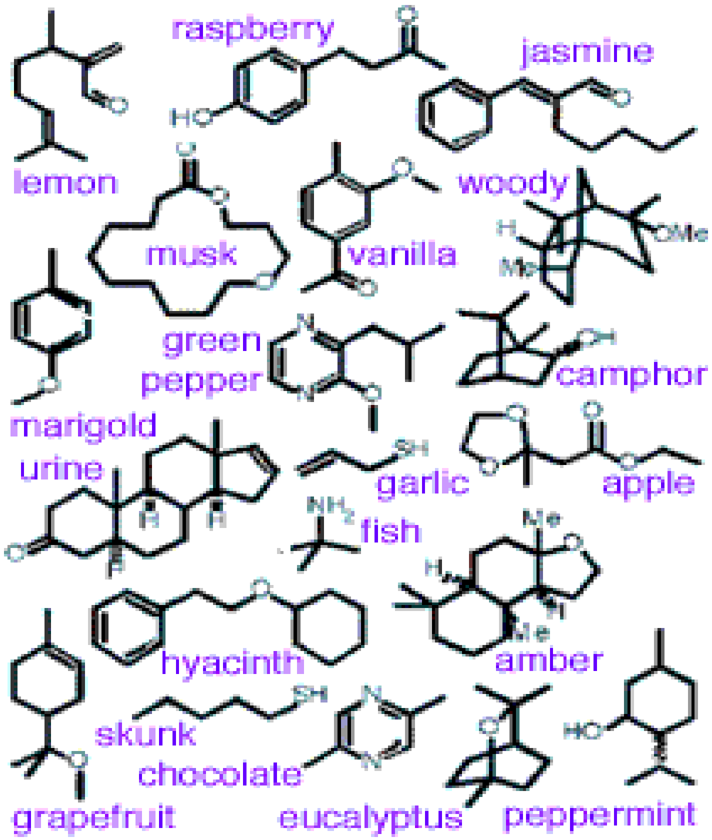
Chemical language



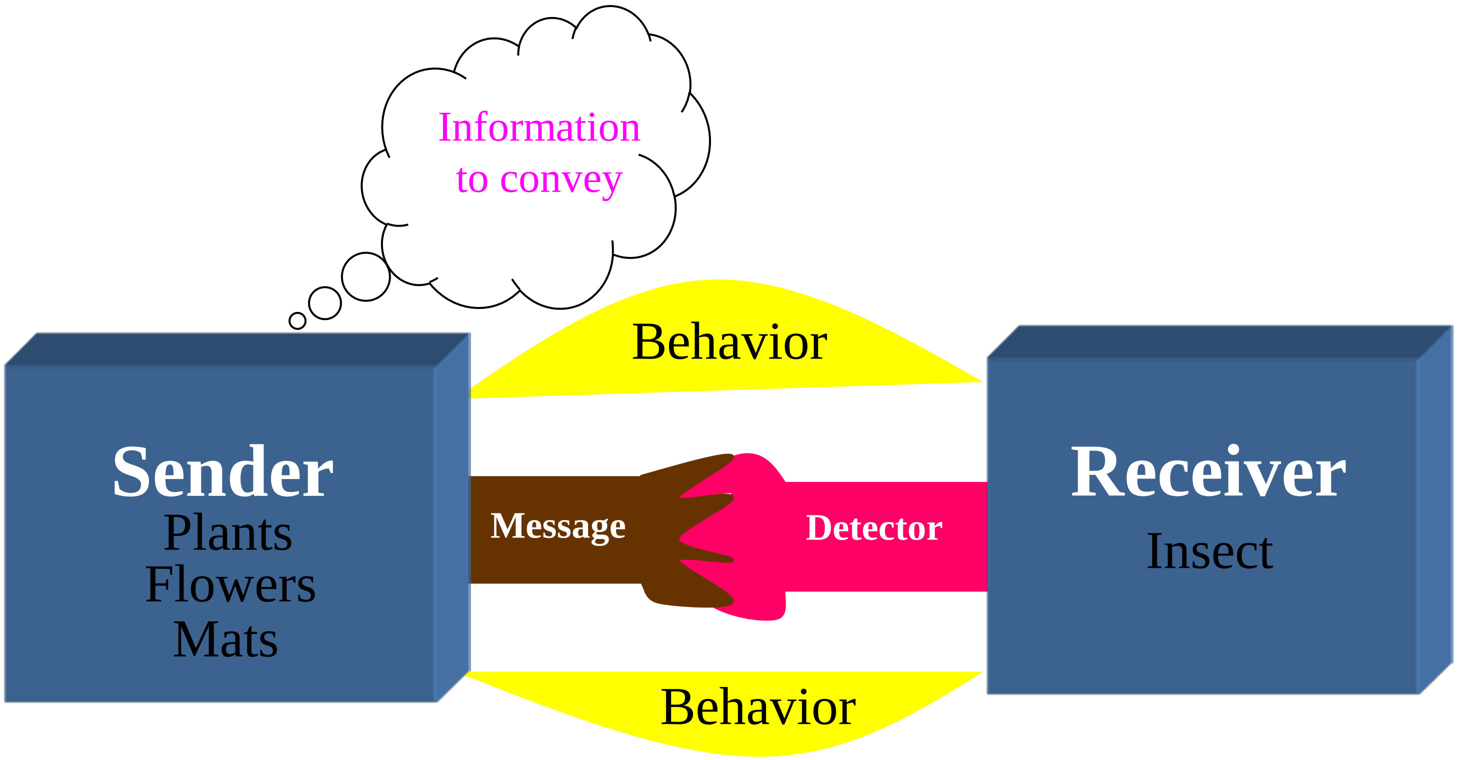

Flowers Plants Mating Partners

Food sources

Language alphabets: Odor molecules

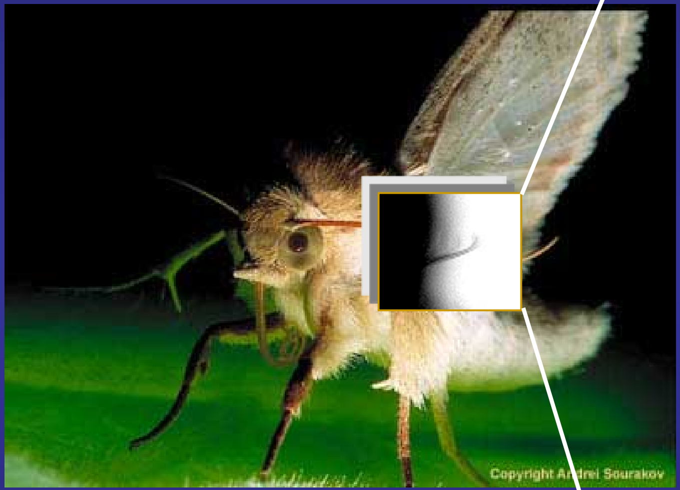


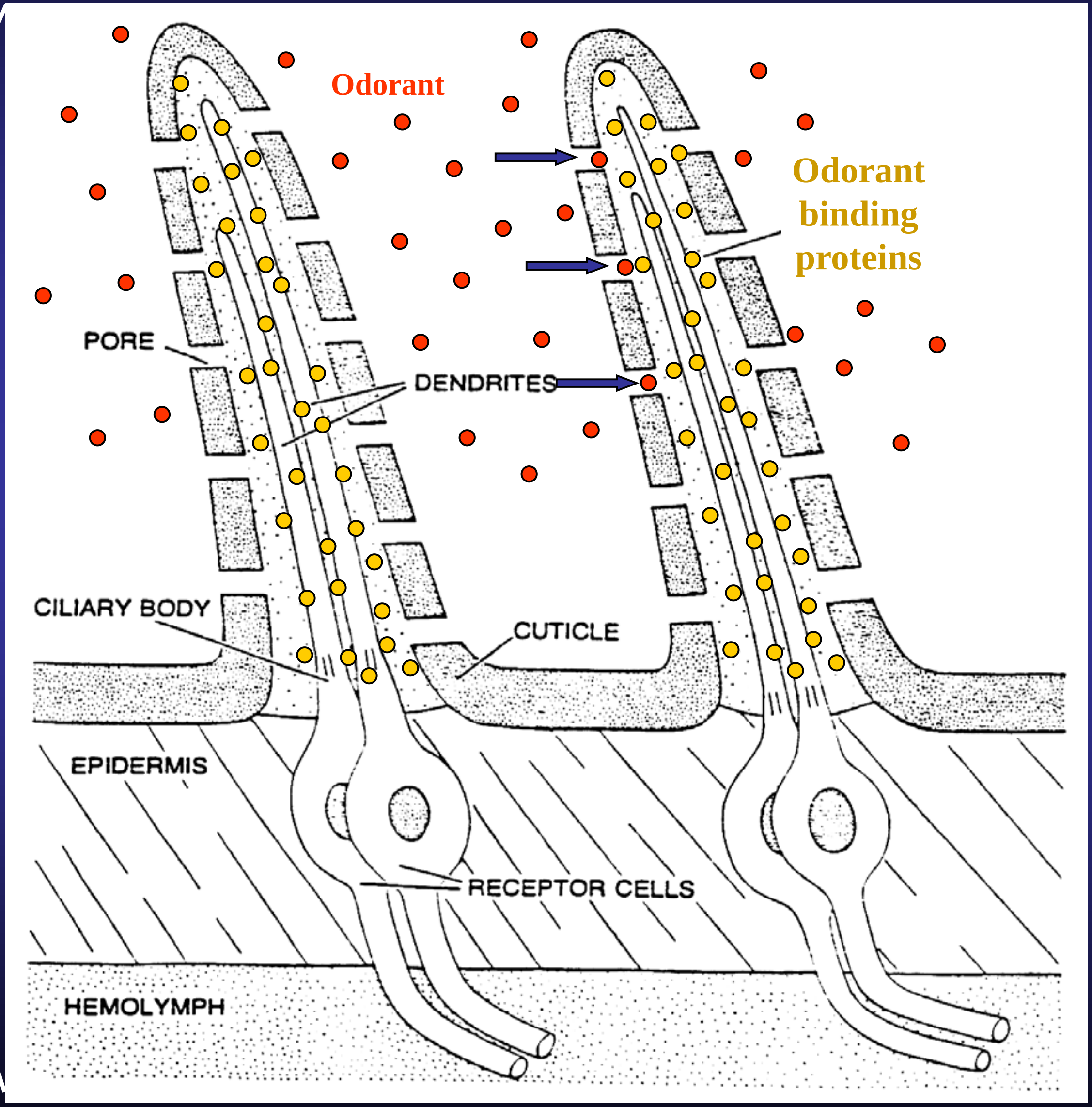
Chemical signals can induce distinct behaviors



Insect Antenna is the main Olfactory organ:

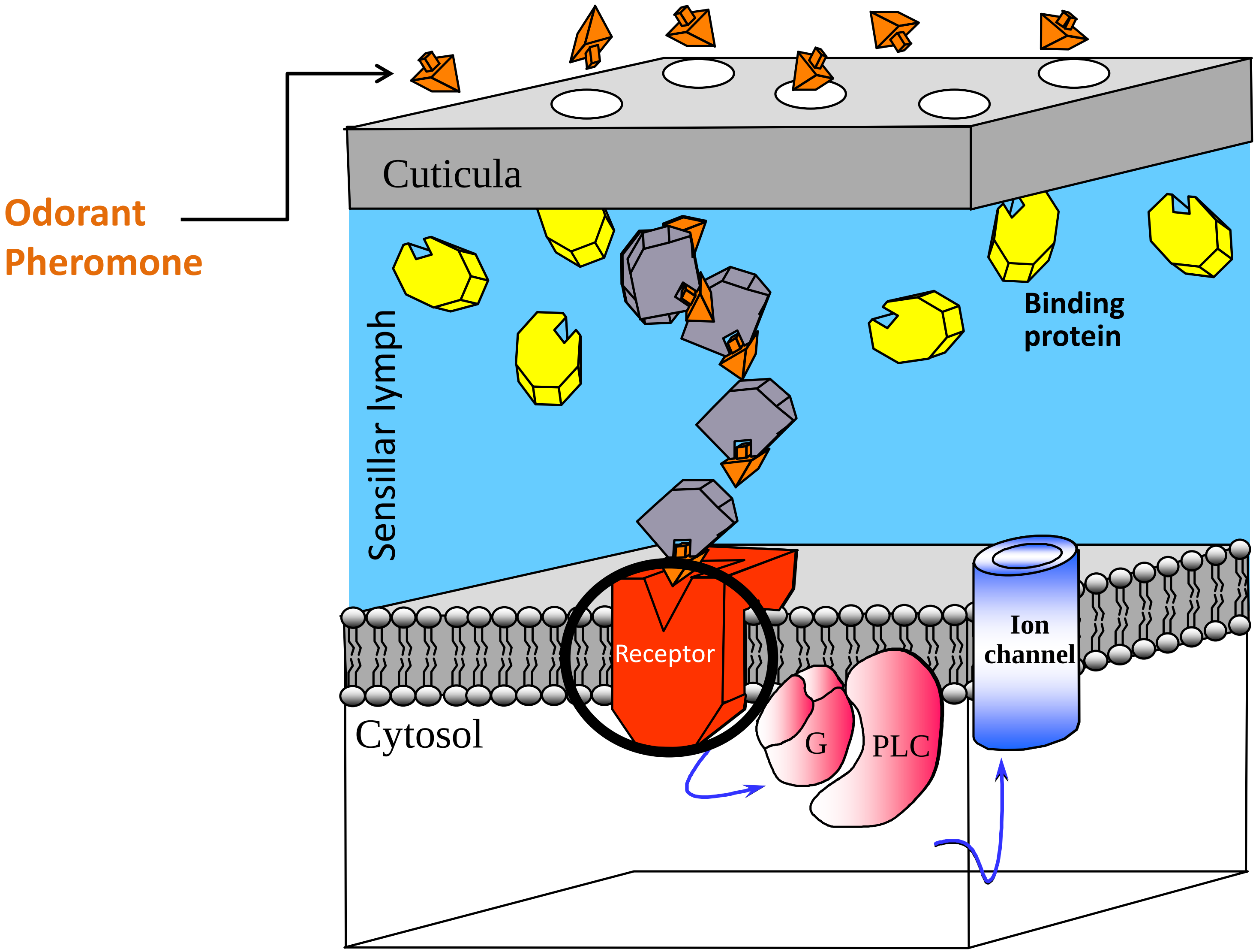
How it works?





(based on Schneider, 1985)

Antenna is the main olfactory organ



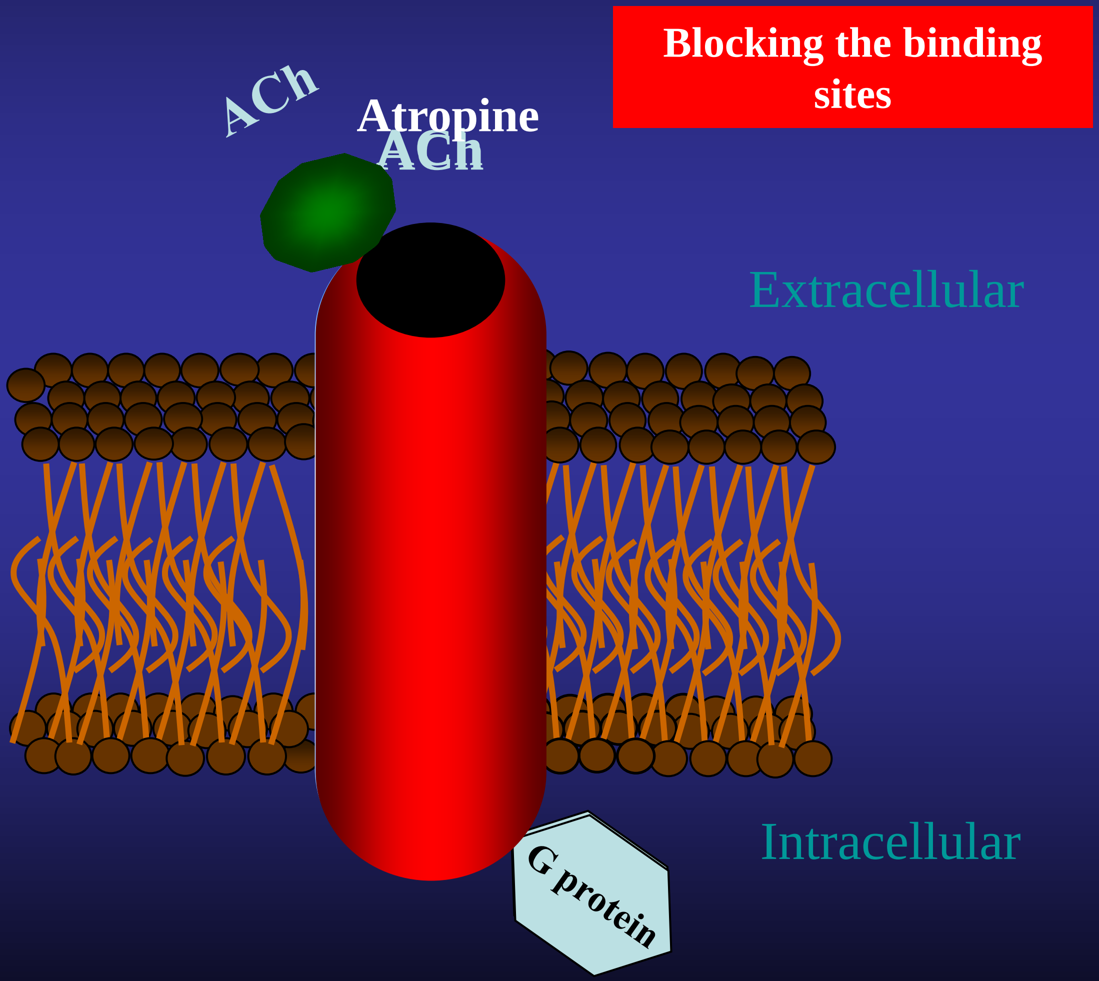
Perspective of olfaction research concerning Pest Control?

Receptors can be blocked by chemical compounds which bind to the receptor but do not activate it; antagonists !

Example: **muscarinic receptor**

Activated by **Acetylcholine (ACh)**

Blocked by **Atropine**



ACh: **Agonist**

Atropine: **Antagonist**

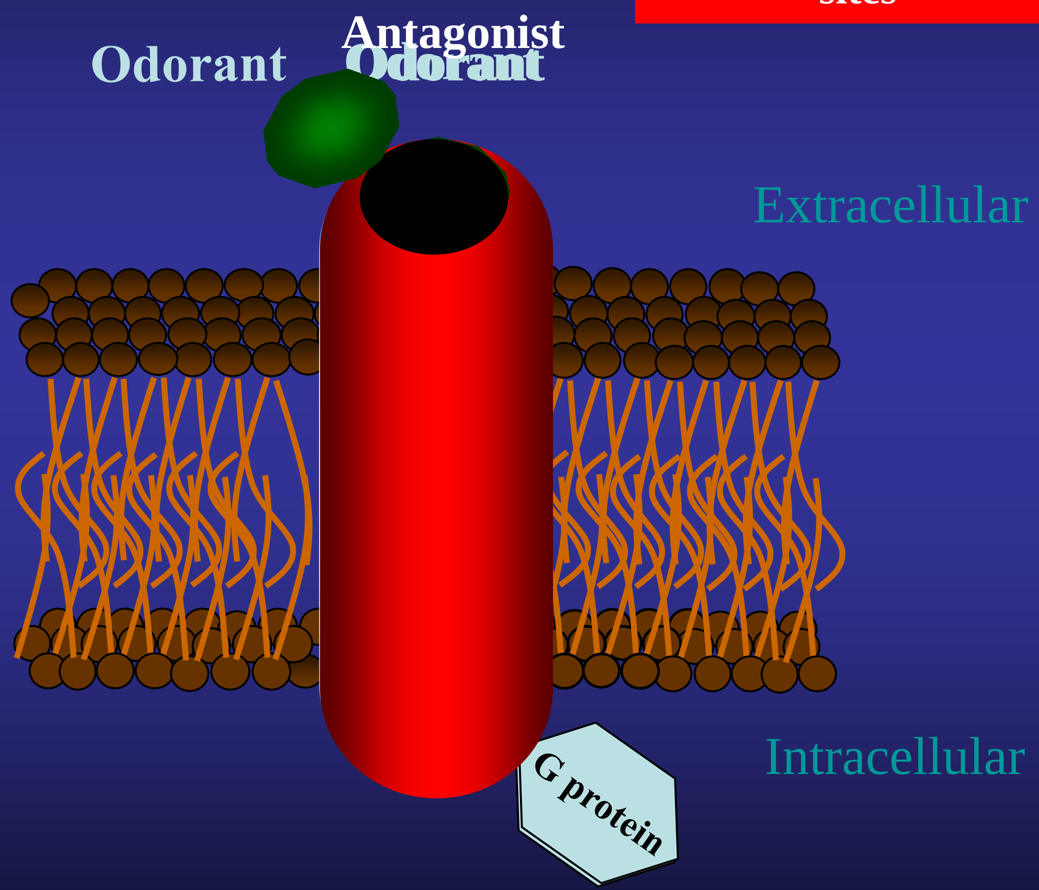
Could the same principle be applicable

for the Odorant/Pheromone receptor?

Odorant

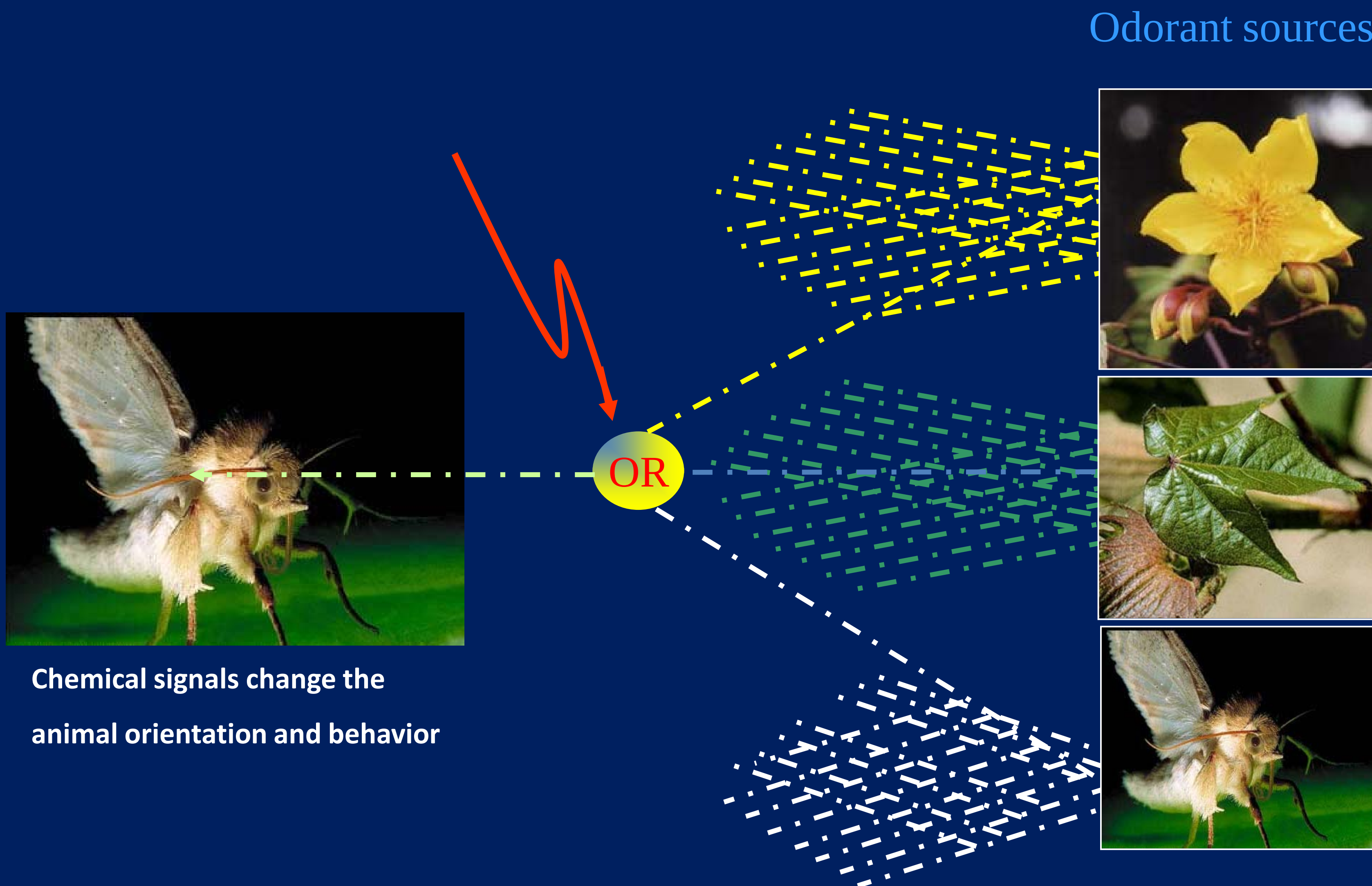
Antagonist ??

Blocking the binding sites

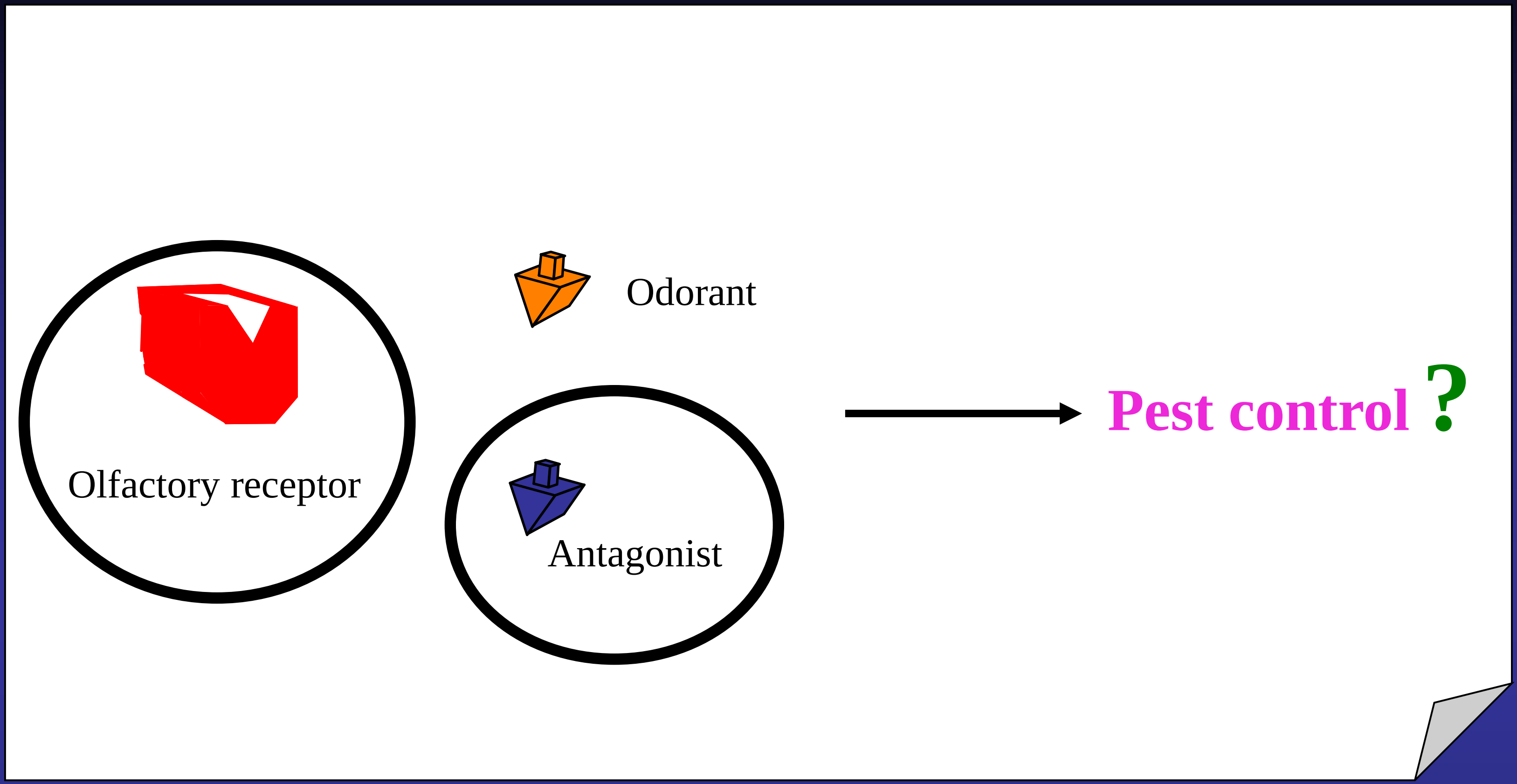


Odorant / Pheromone receptor

- Blocking the receptor will block the perception of chemosensory signals.
- Thereby, the behavior of insects can be manipulated and thus insect populationsc an be controlled.



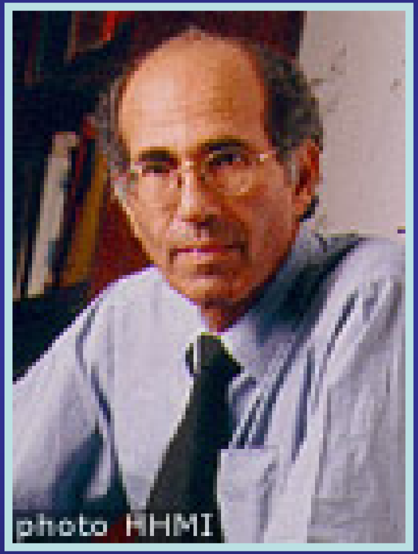
Chemical signals change the animal orientation and behavior



- **What we do need:**
  - Detailed knowledge of the receptor.
  - Search for efficient antagonist.

The Nobel Prize in Physiology or Medicine 2004

"For their discoveries of odorant receptors and the organization of the olfactory system"



Richard Axel

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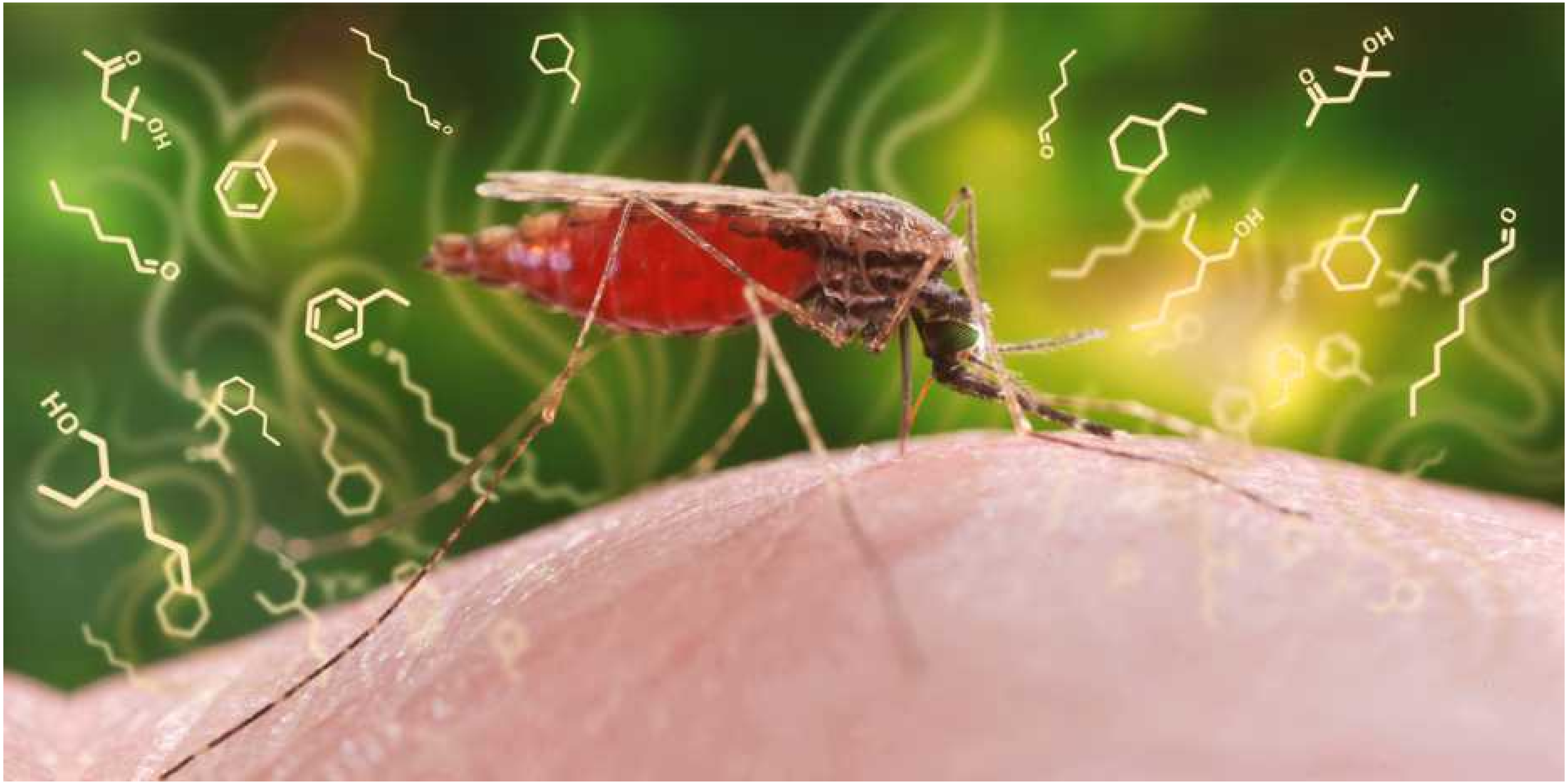
Olfaction Research:

Prevention of Diseases transmitted by insect ..



thank you!