

Allergy and antihistamines

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These slides are from the lectures given at the *Université catholique de Louvain*
by Prof. P Tulkens

A simple question...

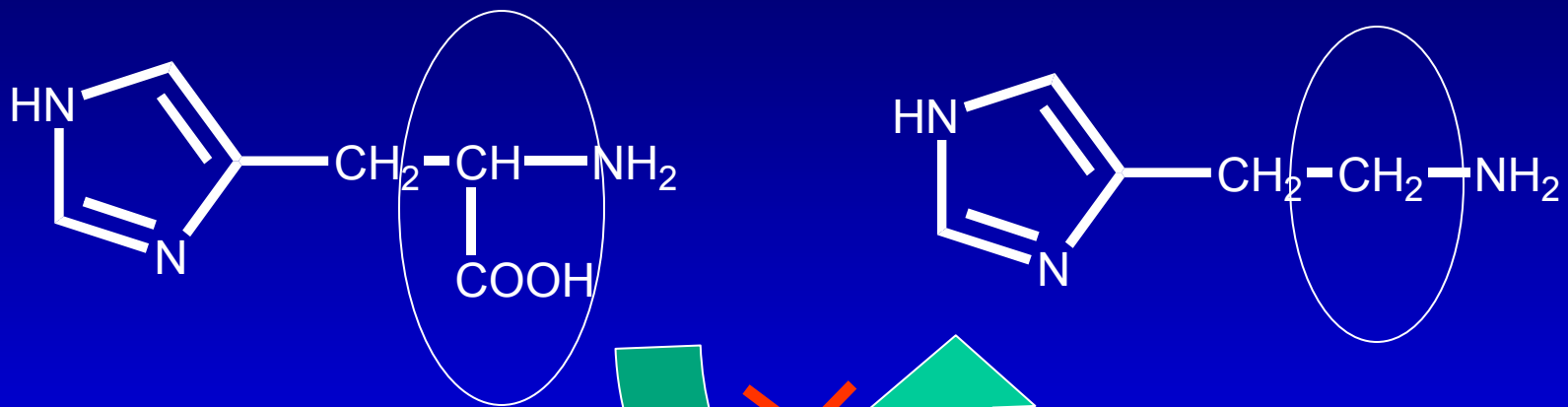
How was histamine discovered ?

- by chemical synthesis ...
- from the analysis of plant extracts (ergot fungus *Claviceps purpurea*)
- from the analysis of animal tissues extracts
- through none of these approaches

Histamine ...

- ➔ obtained by synthetic chemist in 1907 ...as a chemical curiosity ...
 - detection of an identical compound in an extract from ergot fungus ... and shown to cause a marked vasodilatation
 - a similar effect is seen with tissues extracts
 - produces a similar picture as a very severe allergic reaction
 - ➔ recognized as a "biological" molecule (and not a product from putrefaction in 1927 ...

From histidine to histamine ...

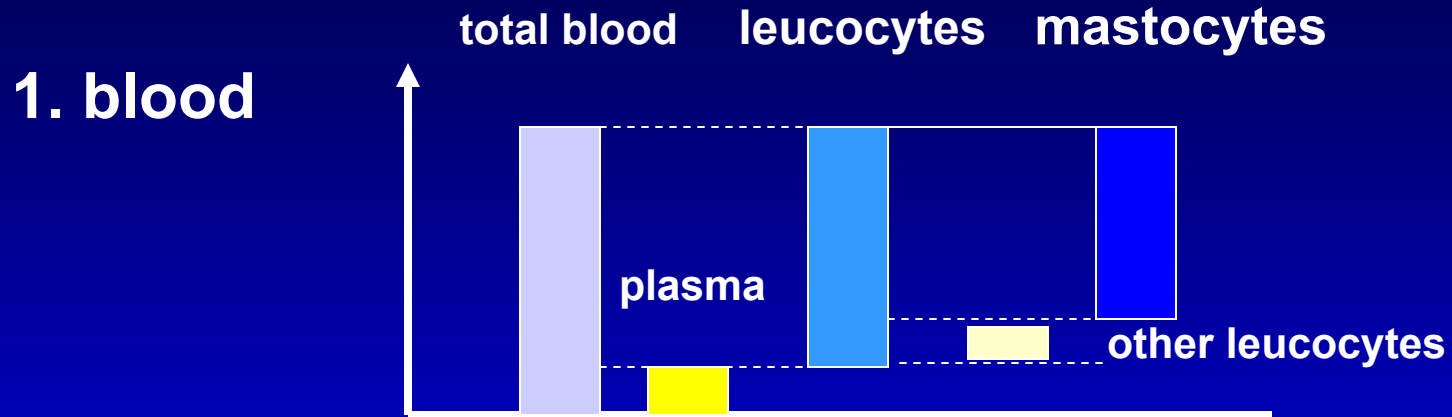


L-histidine decarboxylase

tritoqualine

First inhibitor
of histamine action ...
commercialized in France
(HYPOSTAMINE[®])

Localization of histamine



2. tissues ... the word comes from ἵστος ("*histos*" = tissue !!)

- skin
- lung
- gastrointestinal tract
- central nervous system

Actions of histamine

- **↑ of capillary permability and vasodilatation**
 - rednesses
 - inflammation
- bronchoconstriction
 - important with the guinea-pig but under H_2 retrocontol in man
- **↑ of HCl secretion**
 - (pariteal cells of the stomach)
- **neurotransmission**
 - awakening reactions, tachycardia, hypertension
 - nauseas, vomitting
 - migraines



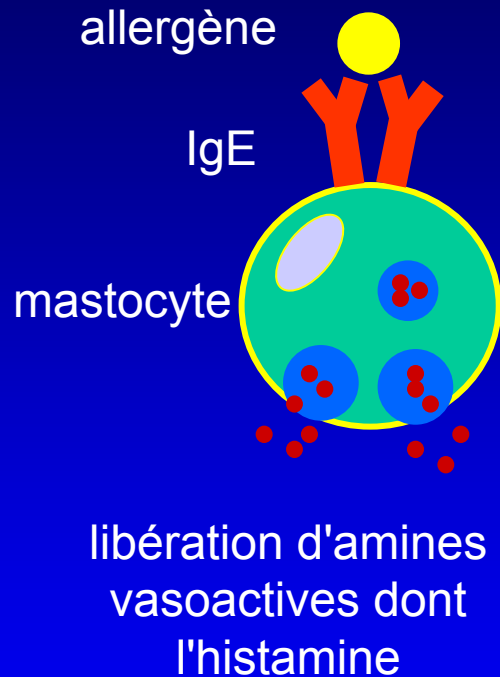
cutaneous
signs



neurological and
comportmental
signs

Rappel: les 4 types de réactions d'hypersensibilité

Réaction de type I anaphylactique



- rhinite, conjonctivite, urticaire, asthme aigu, (bronchospasme), oedème
- délai: endéans les 30 min

Réaction de type II: cytotoxique

- médiée par les IgG et/ou les IgM
- action directe sur une cellule cible
- implique le complément
- lyse, phagocytose (anémie hémolytique, agranulocytose, thrombopénie)
- délai: 5-12h

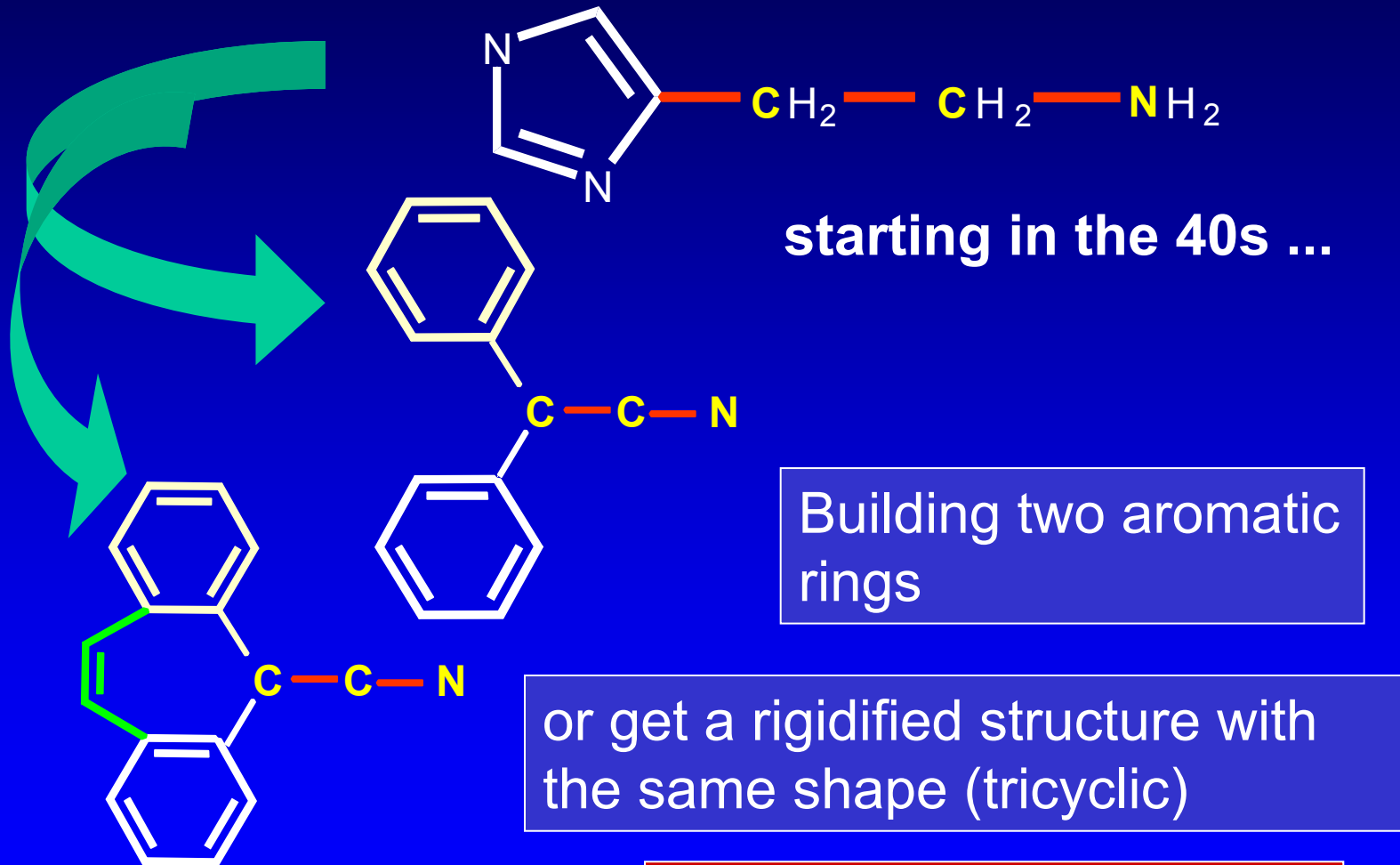
Réaction de type III: formation de complexes immuns

- dépôts dans les tissus avec réaction inflammatoire disséminée
- activation du complément et libération de toxines des leucocytes
- agrégation plaquettaire, microthromboses...
- délai: 3-8h

Réaction de type IV : cellulaire

- activation directe des cellules T
- libération de cytokines et de TNF α
- induit typiquement des manifestations cutanées (dermatite de contact, exanthèmes, eczéma, ...)
- délai: 24 à 48h

From histamine to anti-histamines ...



→ ALL H_1 antihistaminics

Rationalization through a deep understanding of the receptor

- H_1 receptor
 - CNS
 - **périphery**



action mediated by
the phosphoinositides

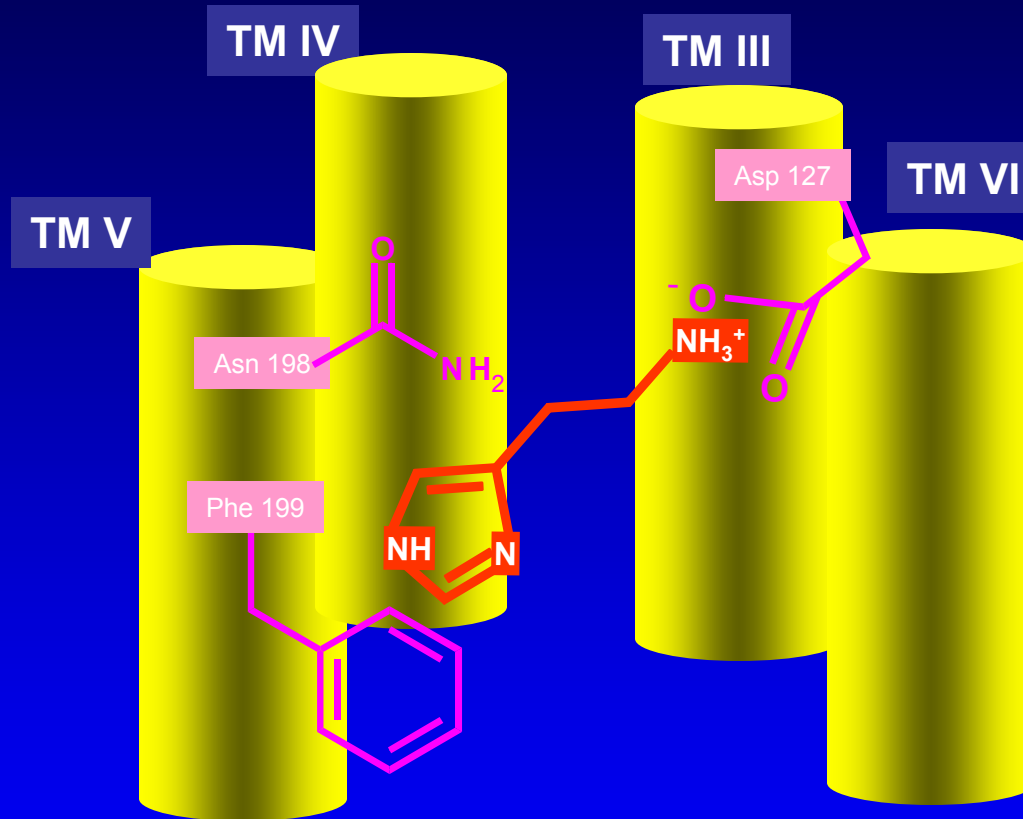
- H_2 receptor
 - **stomach**
 - lung
 - CNS



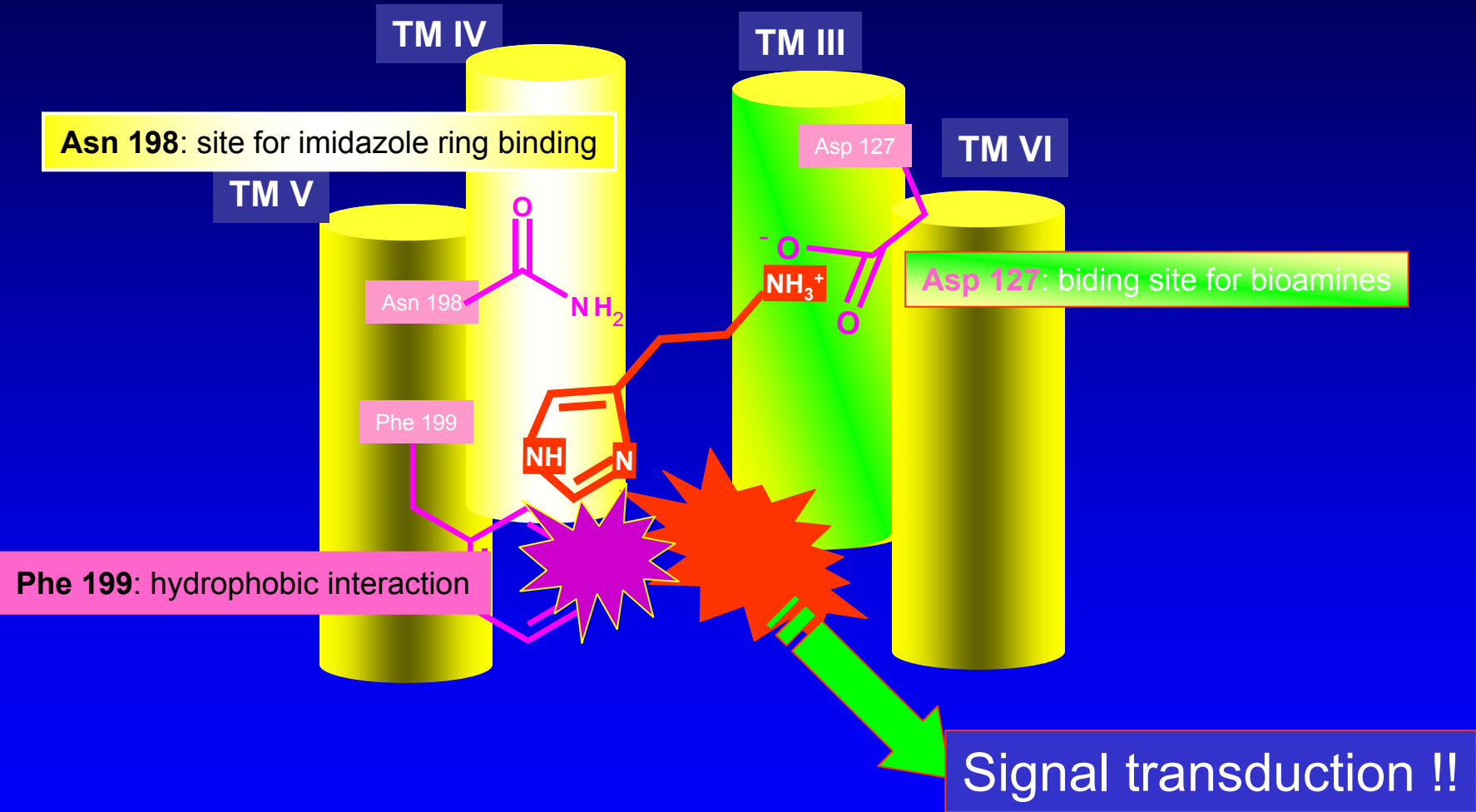
action mediated by
cyclic AMP

- H_3 receptor
 - CNS

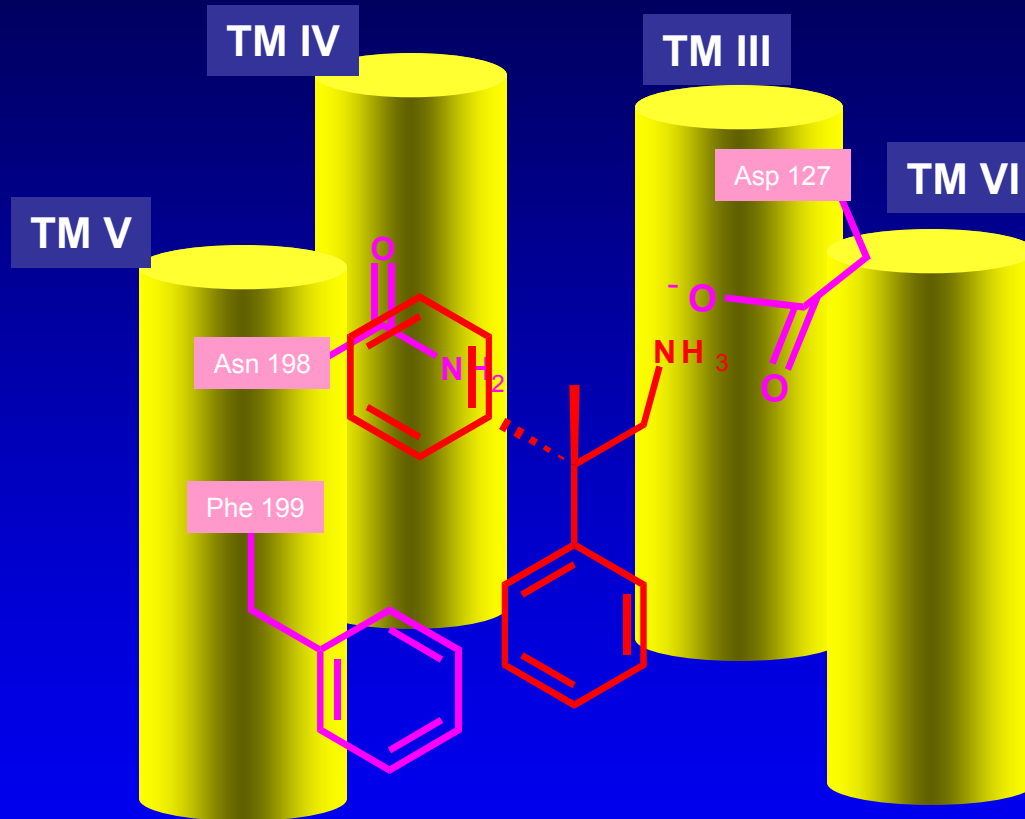
Binding of histamine to H1 receptor



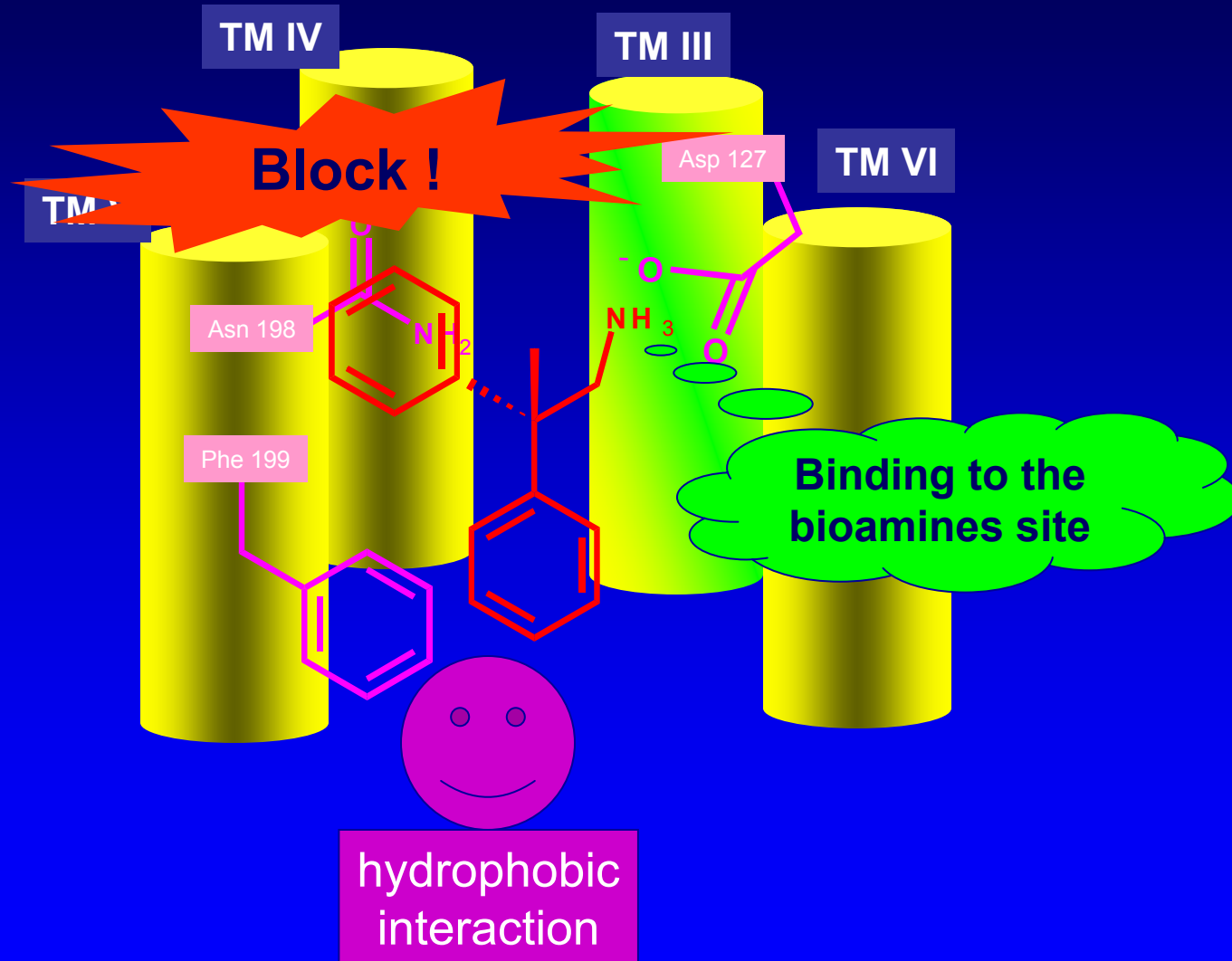
Binding of histamine to H1 receptor



Binding of an antagonist ...



Binding of an antagonist ...



Une famille d'antagonistes H1....

Nom DCI

nom commercial en Belgique *



- alimémazine
- prométhazine
- dimenhydrinate
- diphenhydramine

THERALENE
PHENERGAN
PARANAUSINE / VAGOMIN
BENYLIN



- dexchlórphéniramine
- ciproheptadine
- dimétindène
- méclozine

POLARAMINE
PERIACTIN
FENISTIL
AGYRAX / POSTAFENE
ZYRTEC / REACTINE /
CLARITINE / SANELOR
TELFAS



- cetirizine
- loratadine
- fexofenadine

et plus récemment

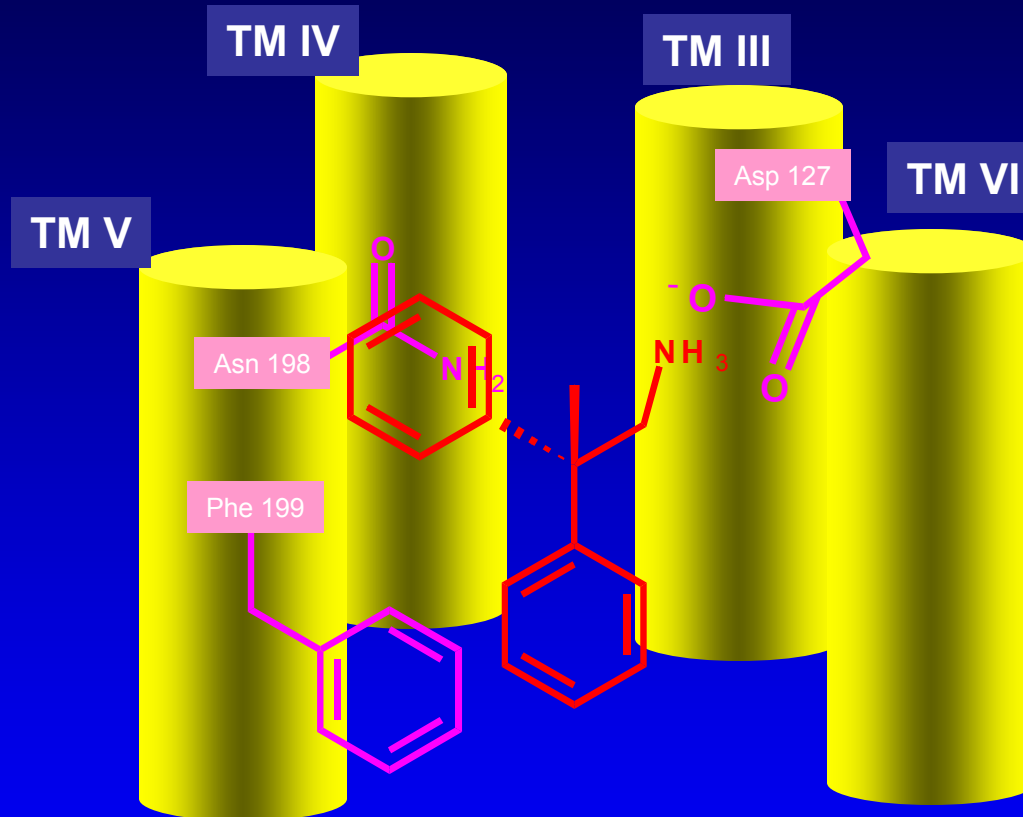


- lévocetirizine
- desloratadine

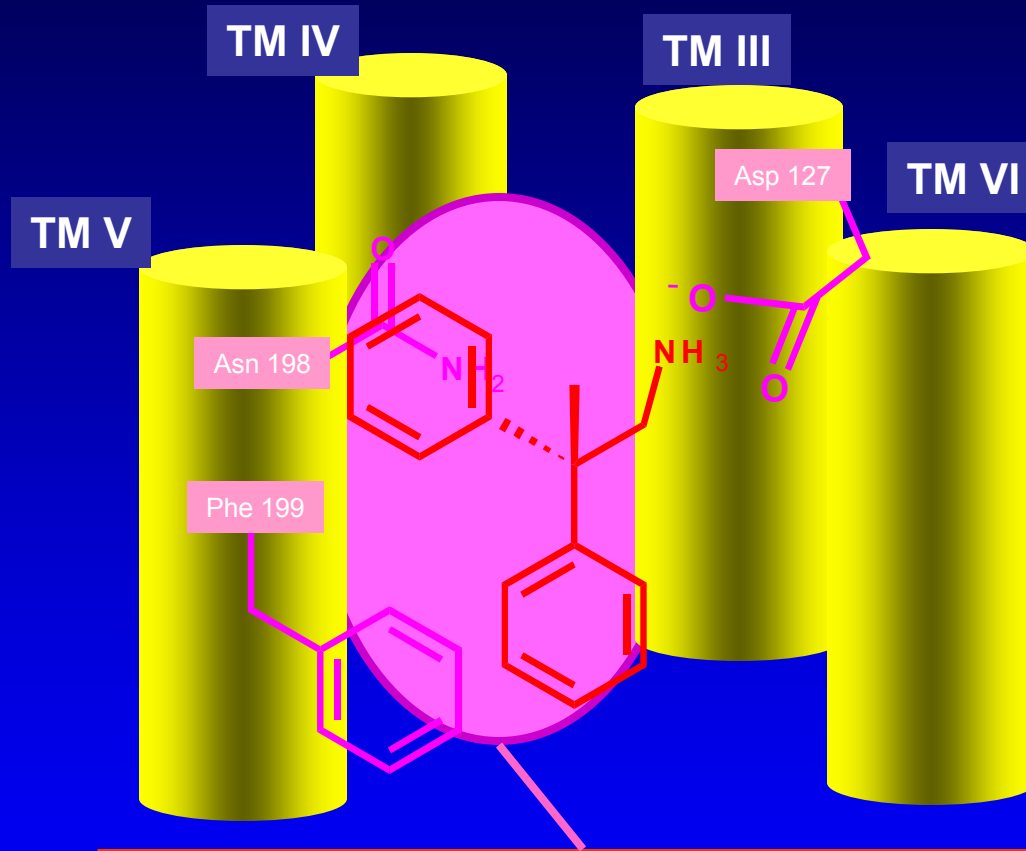
XYZAL
AERIUS

* liste non limitative...

Binding of an antagonist: what can you modify ?

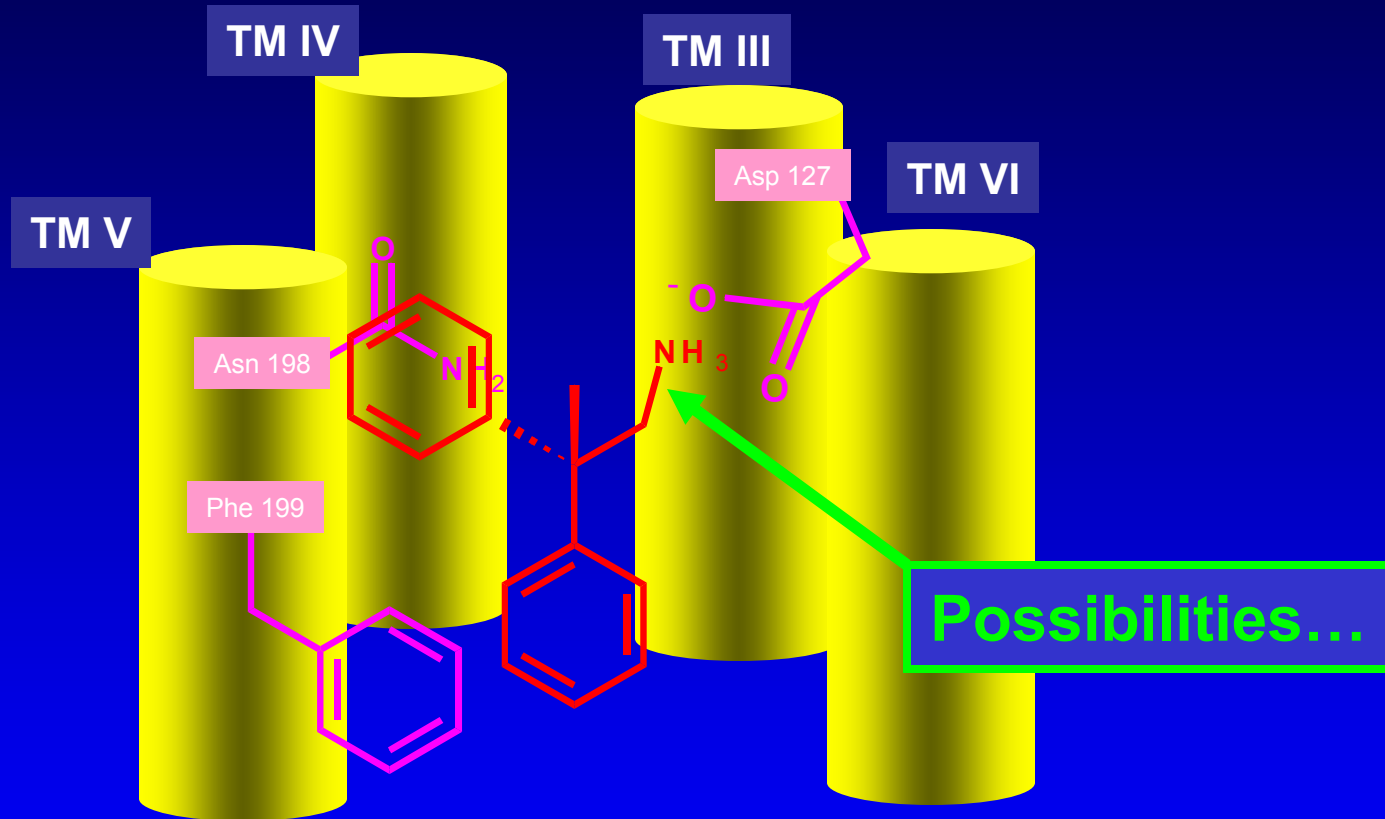


Binding of an antagonist: what can you modify ?

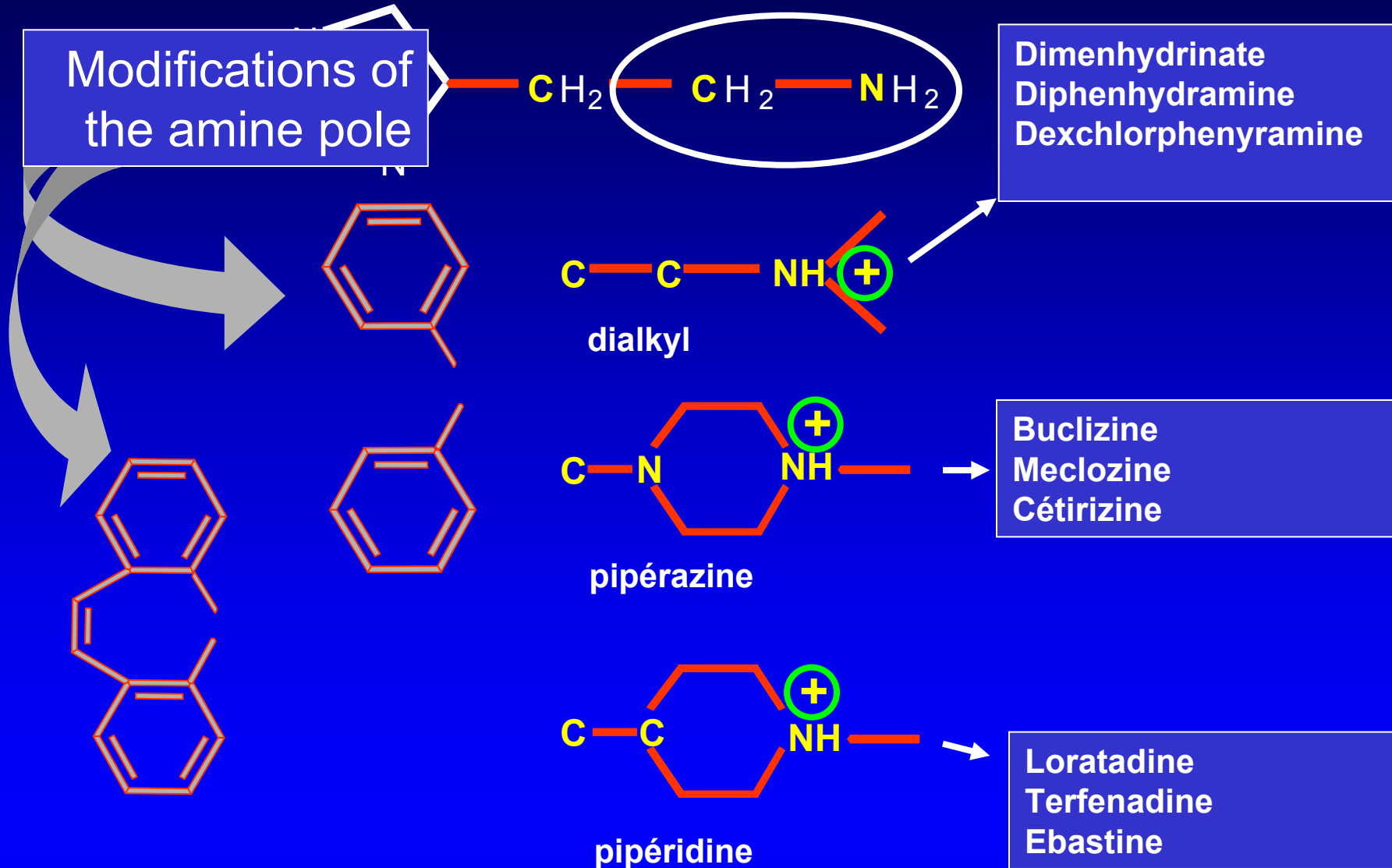


Not much, or very little here ...

Binding of an antagonist: what can you modify ?



Variations among antihistamines....



The ideal antihistaminic drug for the treatment of allergy

What is your "wish list" ?

- Low sedation activity *
- No or little anticholinergic effects **
- Getting a rapid and prolonged action ***

* most "old" antihistamines make you to fall asleep...

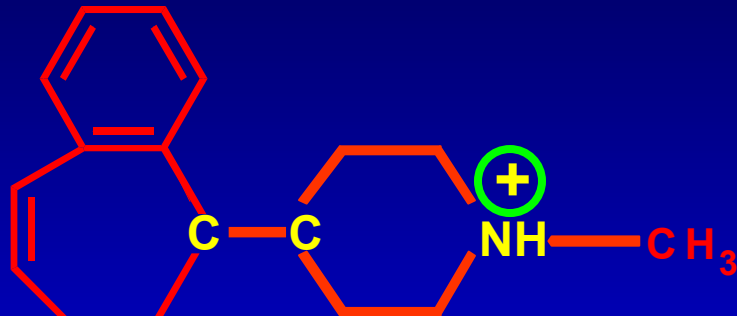
** because their structure is reminiscent of atropine

*** I want a fast relief, and not needing taking pills every hour...

Low sedation activity ...

➔ Modulation of the hematoencephalic barrier passage...

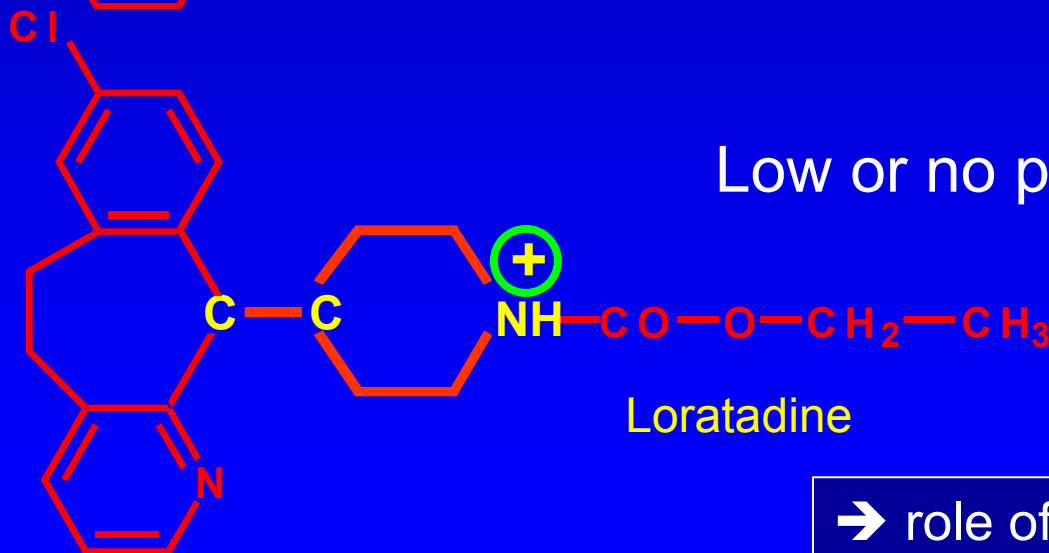
Fast and important passage



Cyproheptadine



Low or no passage



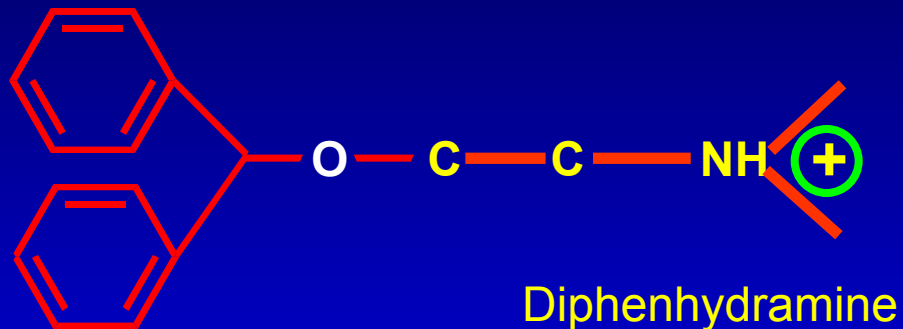
Loratadine



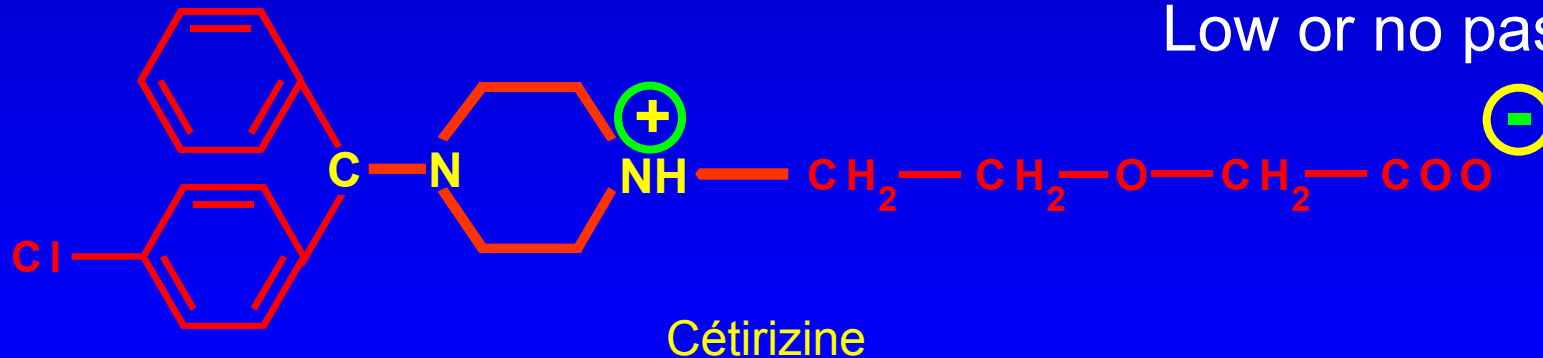
➔ role of the side-chain...

Low sedation activity ...

Another example...



Important passage



Low or no pasage



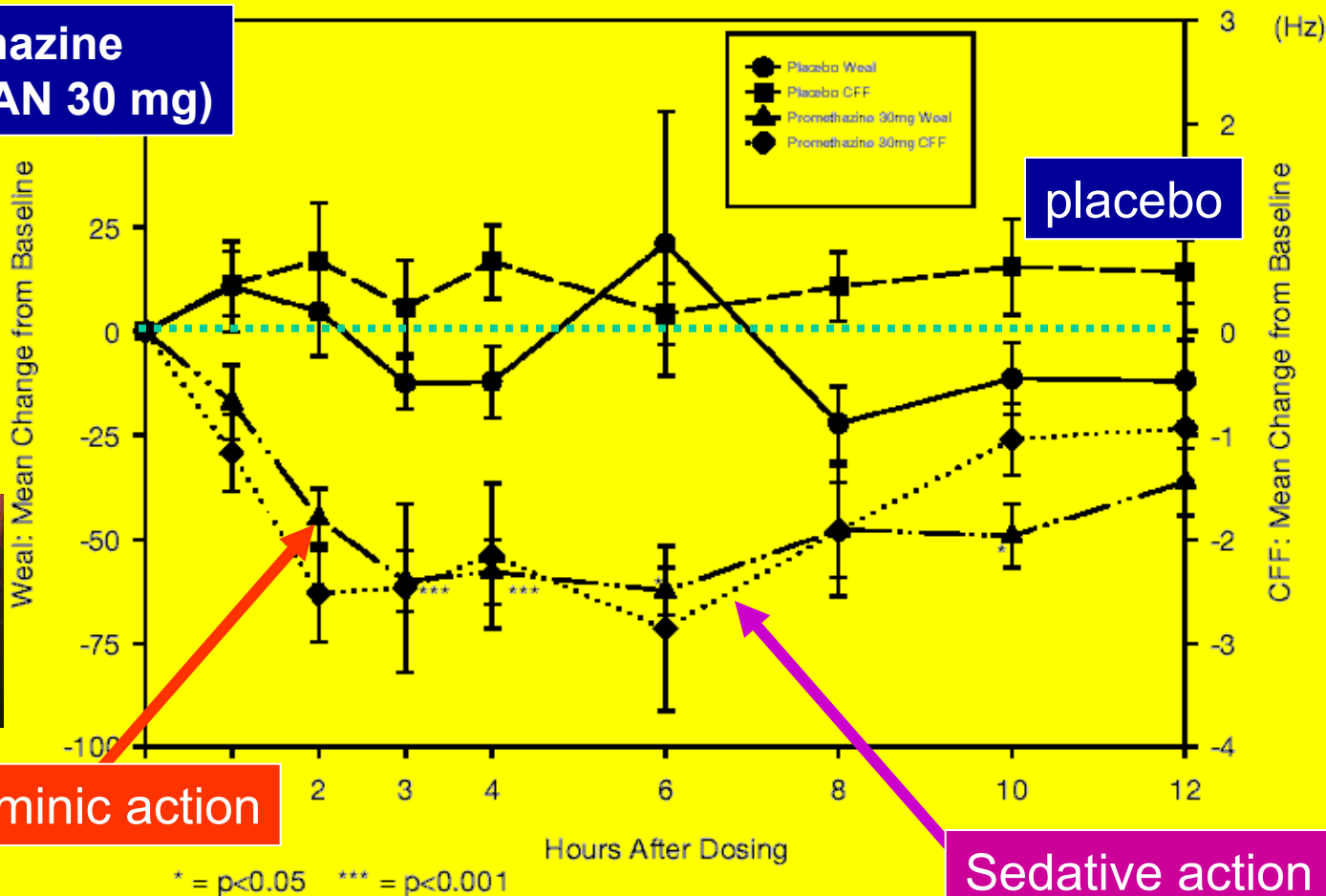
→ role of the length and of the polarity of the side-chain

Molécules à passage hémato-méningé important et causant de la sédation ...

Nom DCI	sédation	OTC
alimémazine	+++	oui (partiel.)
<u>prométhazine</u>	+++	oui
dimenhhydrinate	+++	oui
diphenhydramine	+++	oui
oxomémazine	++	non
<u>dexchlorphéniramine</u>	++	oui
ciproheptadine	++	oui
dimétindène	+	oui
méclozine	+	oui
	+	oui

The antihistaminic and the sedative actions of the "old" antihistaminics go side by side

**Promethazine
(PHENERGAN 30 mg)**



Antihistaminic action

Sedative action

Figure 3. Change from baseline: peripheral antihistaminic suppression (weal) with respect to CFF threshold: acute dose promethazine 30 mg, day 1

Hindmarch et al., Curr. Med. Res. Opin., 17:241-255, 2001

First molecules with low level of passage through the hemato-encephalic barrier

- astémisole
- terfénadine

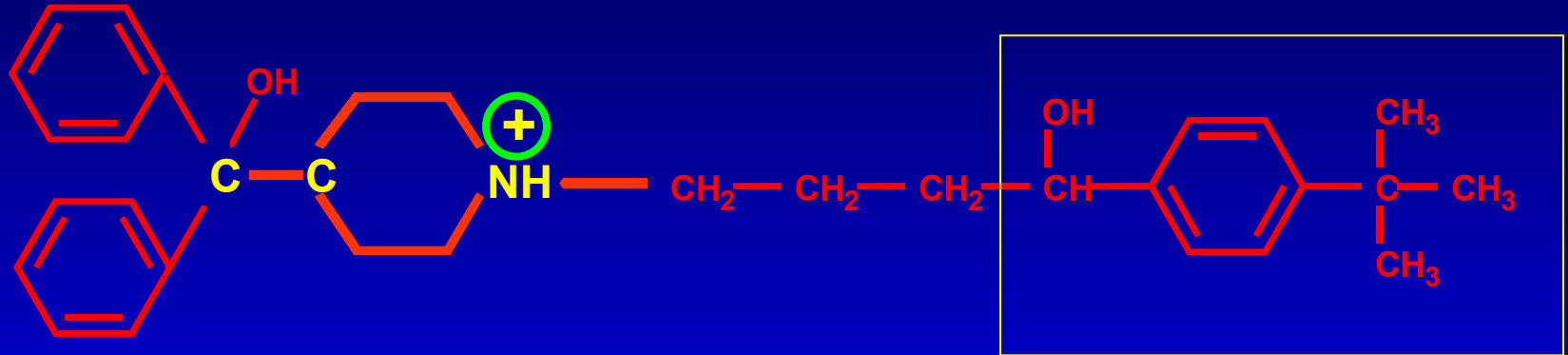
withdrawn because of cardiac toxicity
Torsades de pointe !!!

- fexofénadine

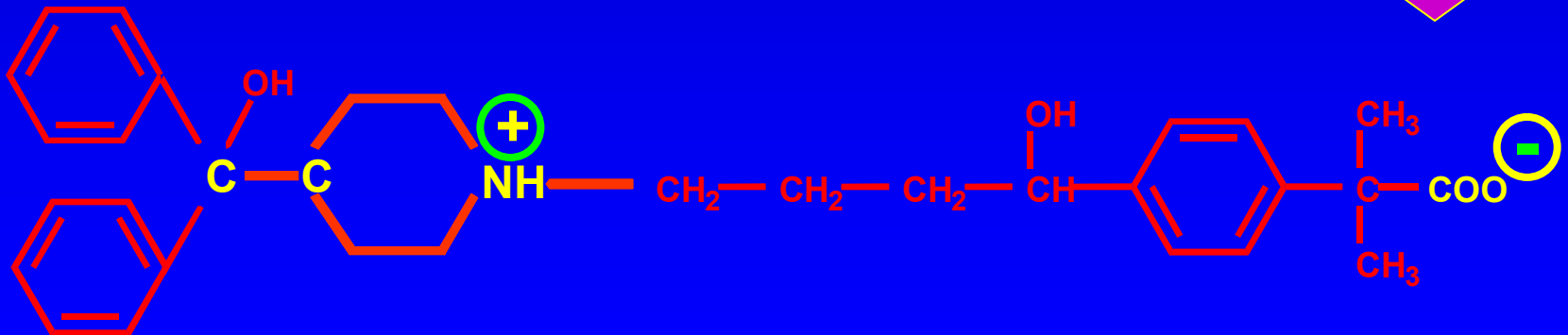
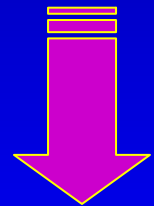
Active metabolite of terfenadine

What was terfenadine...

- terfenadine was a pro-drug

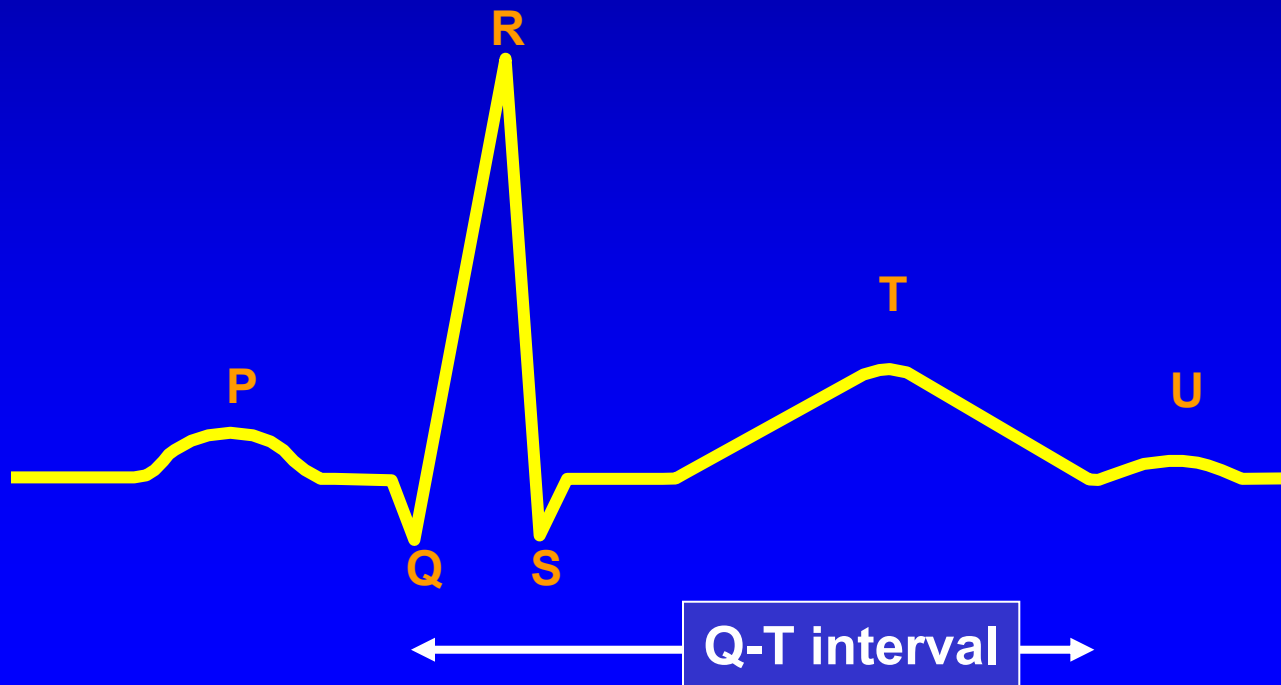


- which underwent a "first pass" liver metabolism that released fexofenadine, the active product

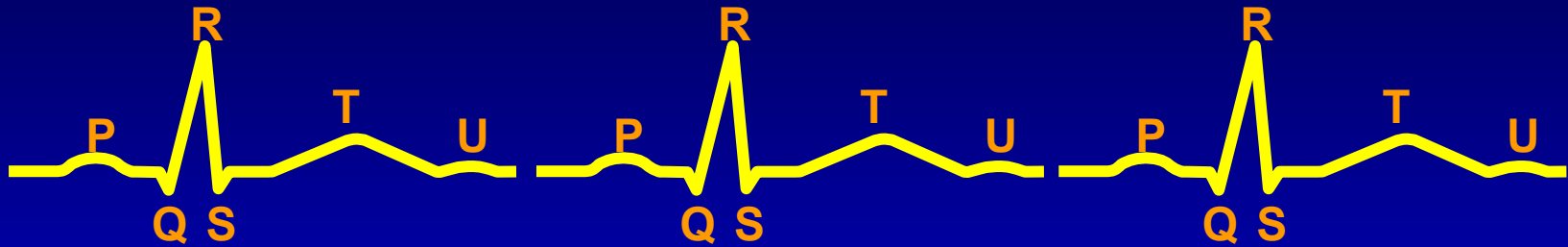


The main problem of terfenadine ...

- if terfenadine reaches the heart, it will block the K^+ canal, causing a delay in repolarization (that translate into a prolongation of Q-T interval [visible at the ECG] that may lead to **life-threatening** arrhythmia and "**Torsades de pointes**" ...



What is "Torsades de pointe" ?



J. Simkó et al. Proarrhythmic Potential of Antimicrobial Agents



Figure 1. Initiation of torsades de pointes. Note the prolonged QT interval of the last preceding beat, the twisting polarity and the changing amplitude of the QRS complexes during the arrhythmia.

Risk of Torsade de pointes and inhibitors of cyt P450 metabolism

Table 1

QT interval prolonging drugs metabolized by CYP 3A4, which may possibly interact both pharmacokinetically and pharmacodynamically with macrolides and imidazole antifungals.

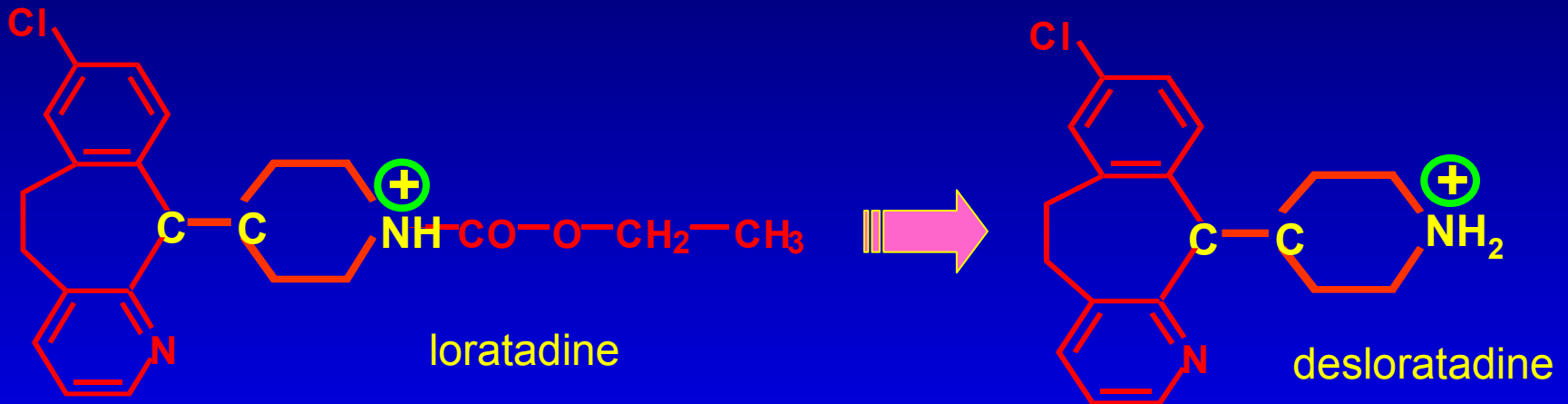
Antiarrhythmics	Amiodarone (with roxithromycin [23]), quinidine (with erythromycin [116]), disopyramide (with clarithromycin [117, 118])
Antifungals	Fluconazole, ketoconazole, itraconazole, miconazole
Prokinetics	Cisapride (with clarithromycin, [119, 120], with erythromycin [121])
Antihistamines	Terfenadine (with erythromycin [122, 123], with troleandomycin [124]), astemizole (with erythromycin [125]), loratidine
Antipsychotics	Pimozide (with clarithromycin [126, 127]), chlorpromazine, haloperidol, ziprasidone, risperidone, clozapine, quetiapine
Immunosuppressive drugs	Tacrolimus
Opioid agonists	Methadone
Antimalarials	Quinine, chloroquine, halofantrine

Case reports on torsades de pointes or QT prolongation during coadministration of macrolide agents and other repolarization prolonging drugs are in brackets

Molecules with a weak hemato-encephalic passage ...

- loratadine

must be metabolized into desloratadine

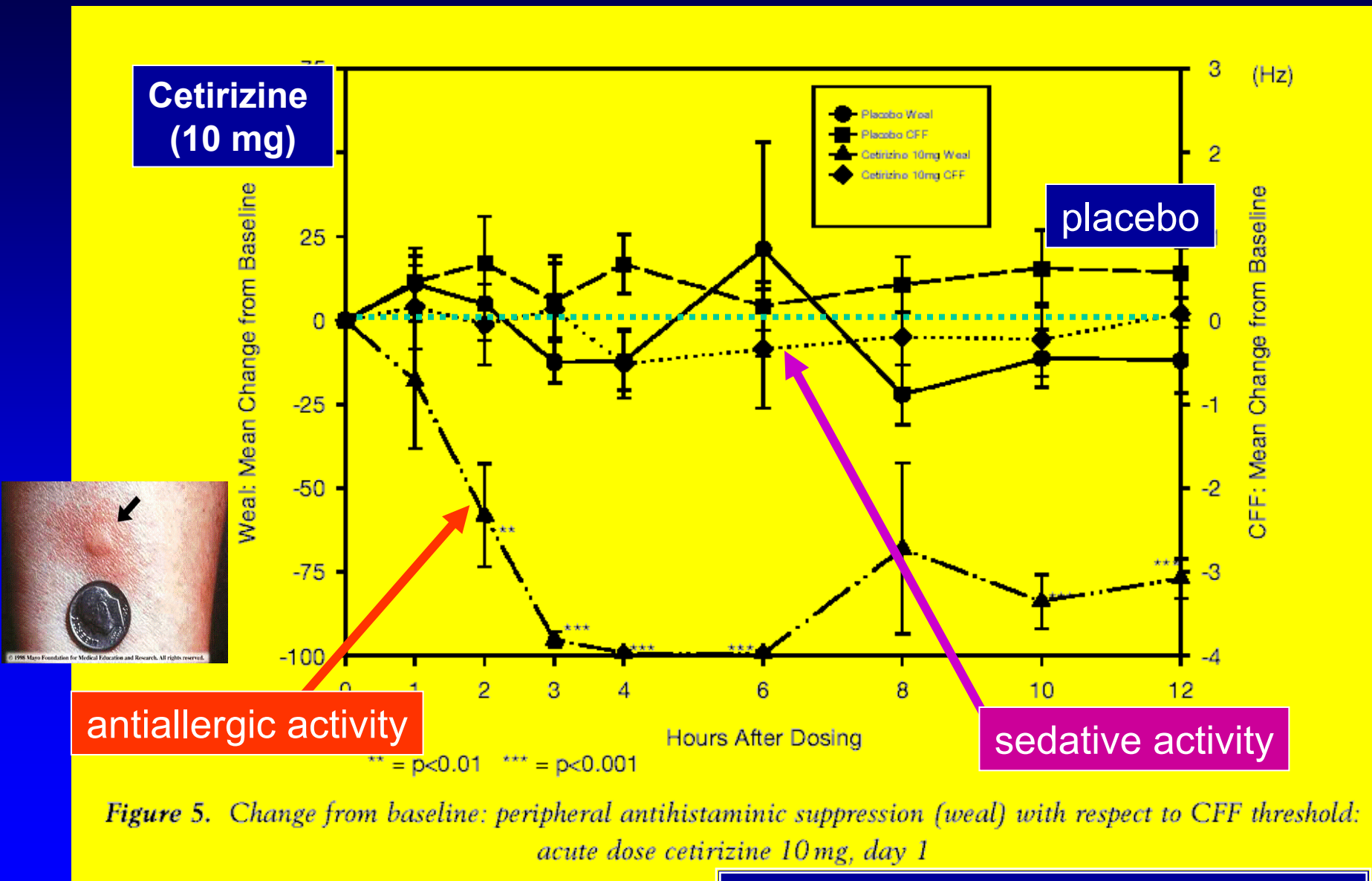


- ebastin

- cetirizine

not very sedative and acting as such

Dissociation of the antiallergic and sedative activities



Hindmarch et al., Curr. Med. Res. Opin., 17:241-255, 2001

Dissociation of anti-allergic and sédative activities...

But, **beware:**



This is all related to dose...

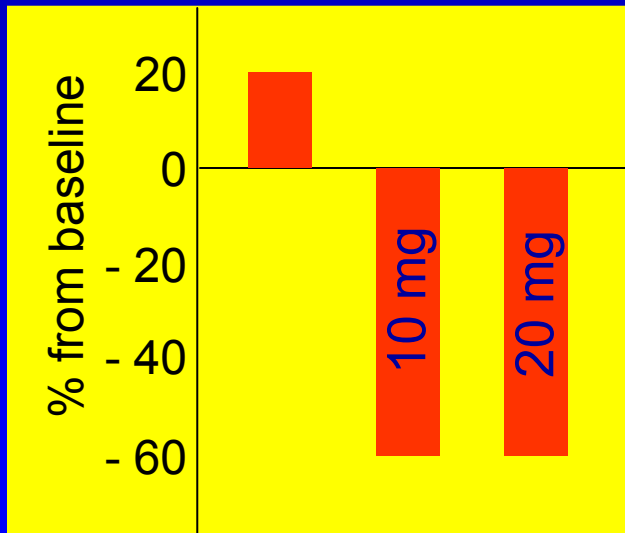
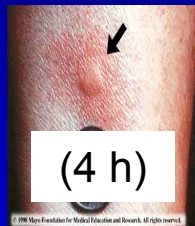
Dissociation of anti-allergic and sedative activities ...

Everything is related to dose...

antiallergic activity

placebo

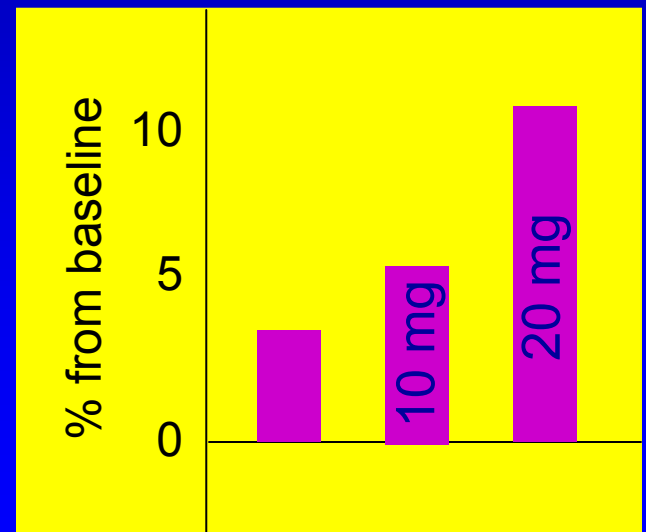
cetirizine



sedative activity

placebo

cetirizine



Sannita et al., Eur. J. Pharmacol. 300: 33-42, 1996

The ideal anti-H1 drug for treating allergy...

Specifications (*Cahier de charges*)

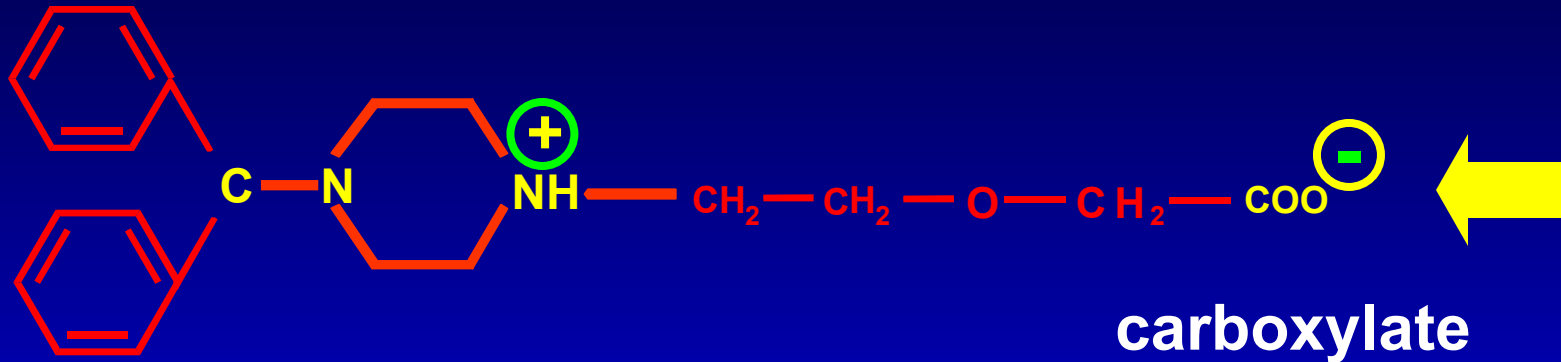
- Low sedative potential
- **Avoiding anti-cholinergic effects...**
 - important for old molecules
(**Hydroxyzine**, **diphenhydramine**, **prométhazine**, cyproheptadine, méquitazine, **dexchlorphéniramine**, alimémazine)
→ sight troubles, urinary retention ...
 - much improved for new ones
(**loratadine**, fexofénadine, **cétirizine**)
- Getting a rapid and sustained action

The ideal anti-H1 drug for treating allergy...

Specifications (*Cahier de charges*)

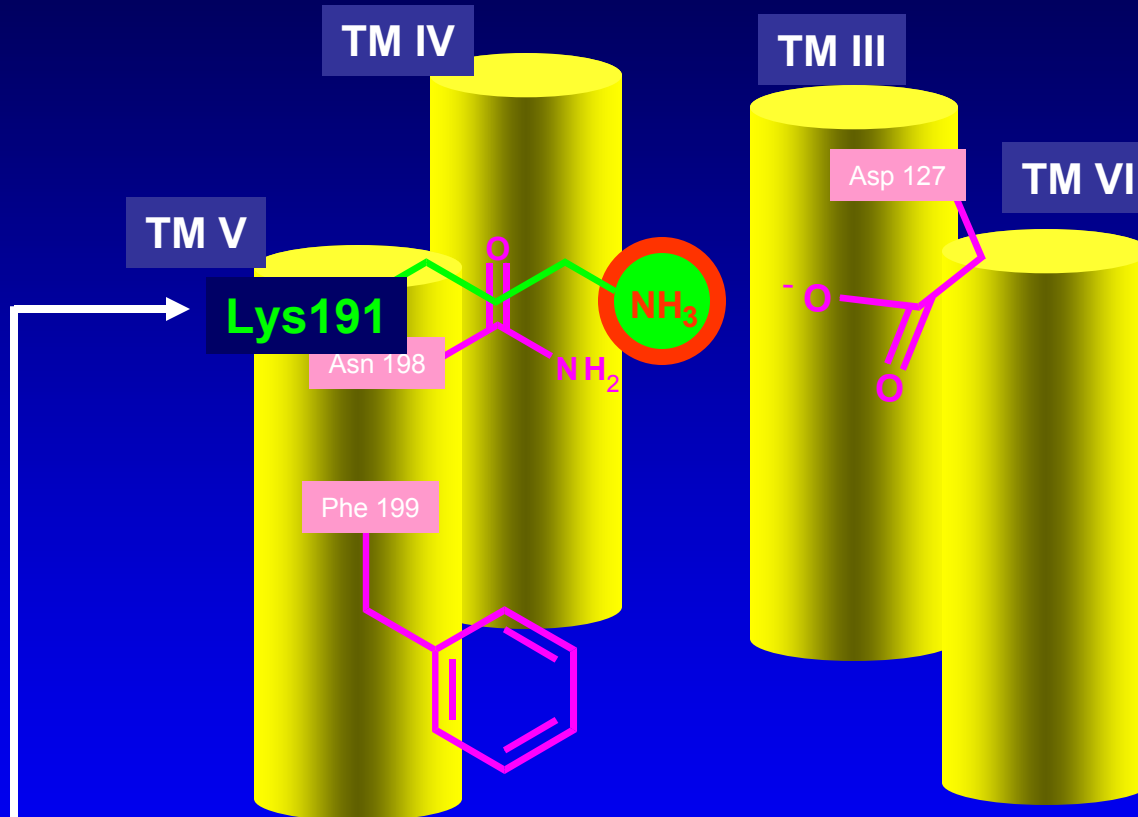
- Low sedative potential
- Avoiding anticholinergic effects
- **Getting a fast and sustained action**

Molecular properties of cetirizine



- fast action because no necessity of metabolic activation (>< terfenadine, loratadine...)
- little or no penetration through the blood-brain barrier
- **long occupation of the receptor**

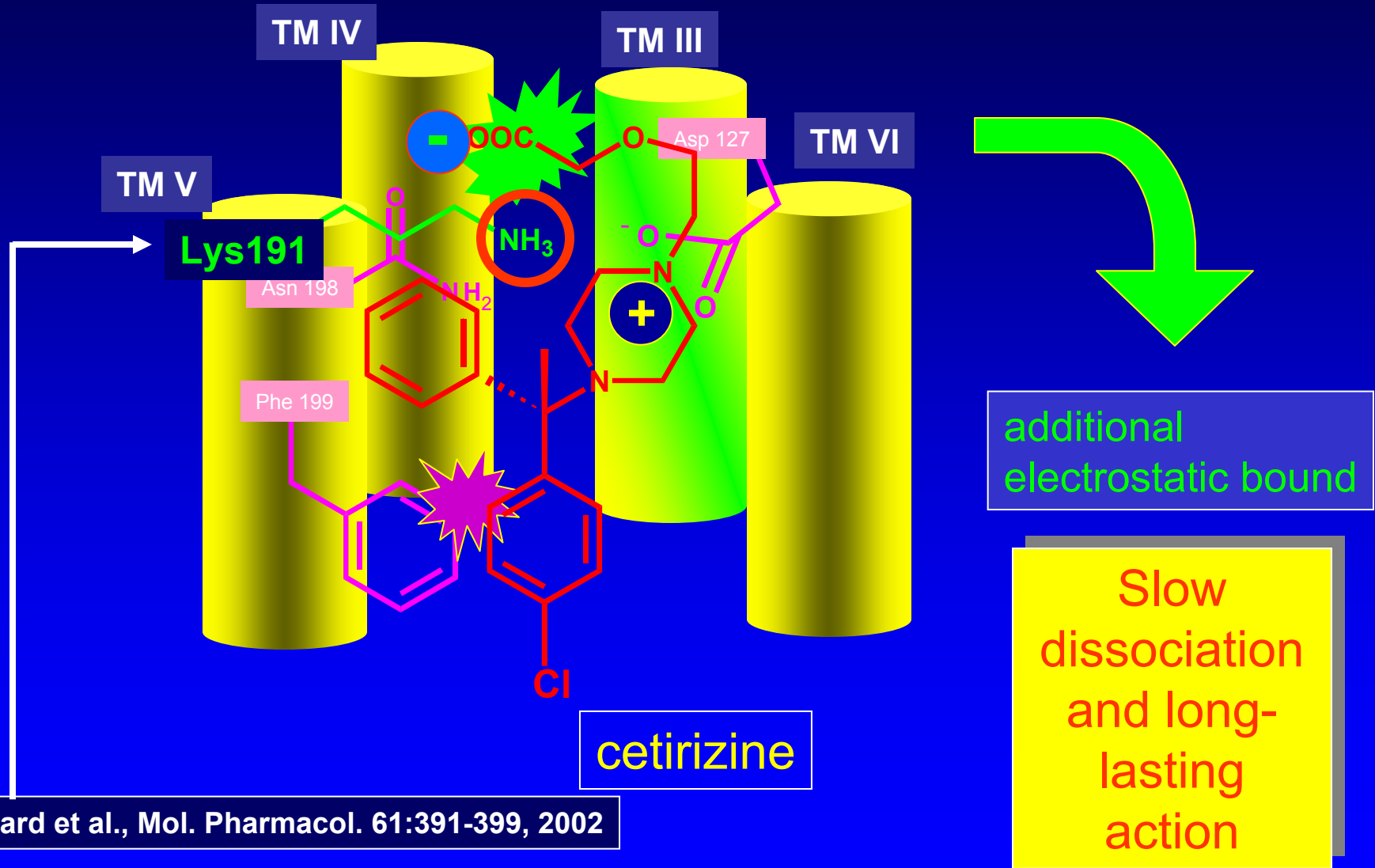
Binding of an H₁ antagonist to the receptor...



Presence
of a lysine
in position 191

Gillard et al., Mol. Pharmacol. 61:391-399, 2002

Slow release of an antagonist ...



Prolonged action ...

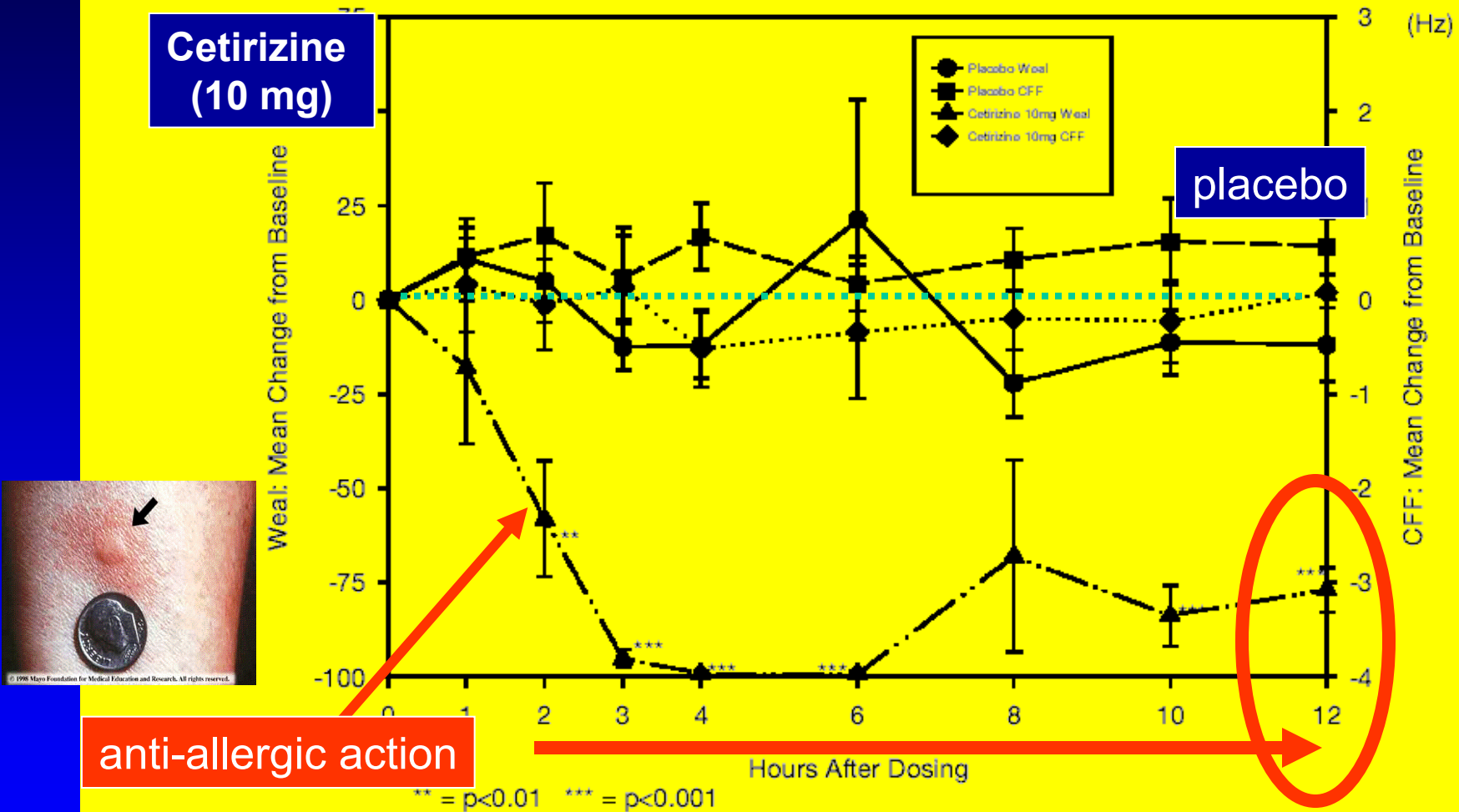
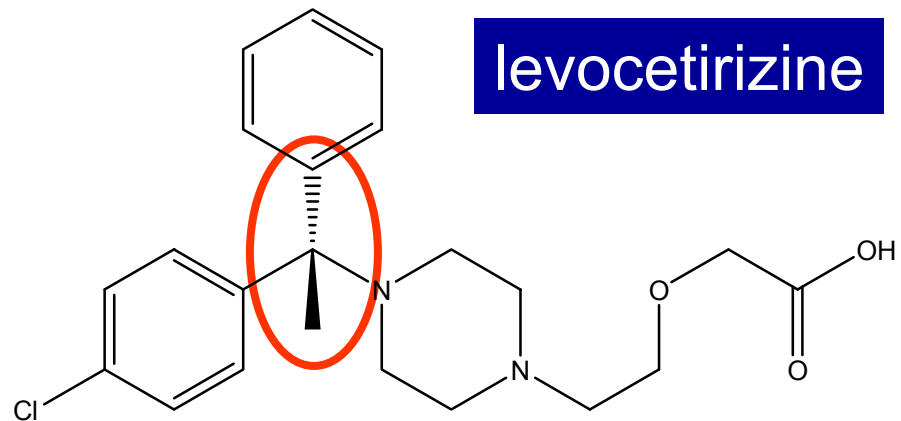
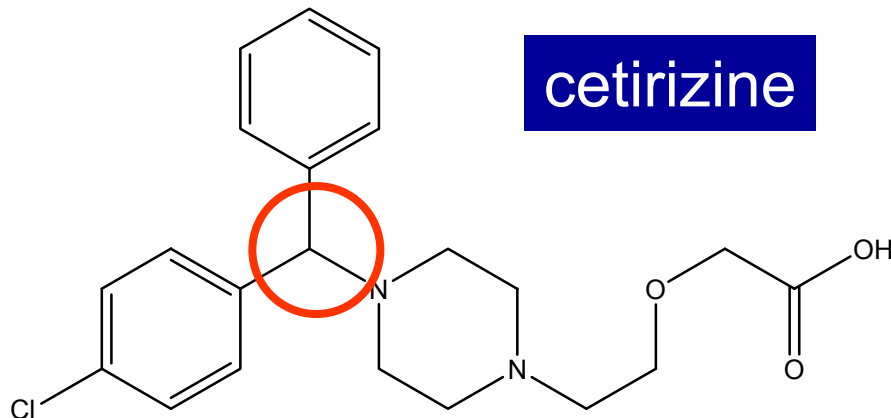


Figure 5. Change from baseline: peripheral antihistaminic suppression (weal) with respect to CFF threshold: acute dose cetirizine 10 mg, day 1

Cetirizine and levocetirizine....



Acetic acid, 2-[2-[4-[(R)-(4-chlorophenyl)phenylmethyl]-1-piperazinyl]ethoxy]-

Une longue histoire, mais ...

Sur base de ce que vous avez appris jusqu'ici, quel est, à votre avis, le conseil le plus essentiel à donner au patient lors de la délivrance d'un antihistaminique de type cétérizine, loratadine ...

- faire attention aux autres médicaments
- ne pas abuser du produit
(ne pas reprendre trop rapidement)
- attention à l'alcool !
- respecter la posologie
- attention à la somnolence