Chimie Biologique

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http://sondesfluorescentes.unice.fr/etudiants/L2SV/portail-l2sv.html

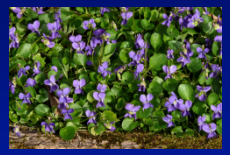
Facebook : L1SV Atomistique

Grasse

« Capitale de la Parfumerie »

Une production locale

Février : Mimosa 

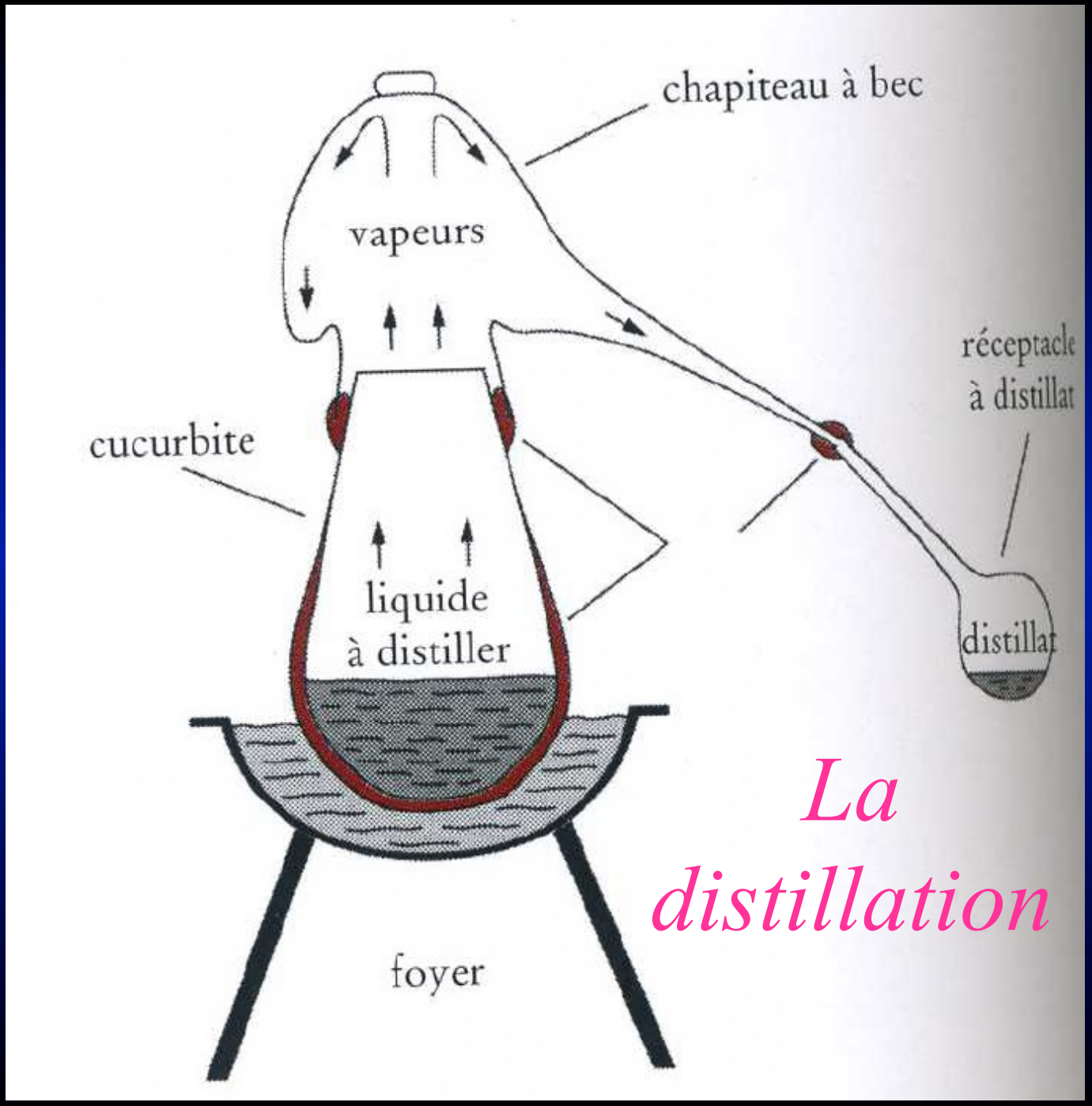
Mars : Violette 

Avril : Jonquille 

Mai : Fleur d'oranger et Rose 

Juin-Septembre : Tubéreuse 

Août-Octobre : Jasmin 



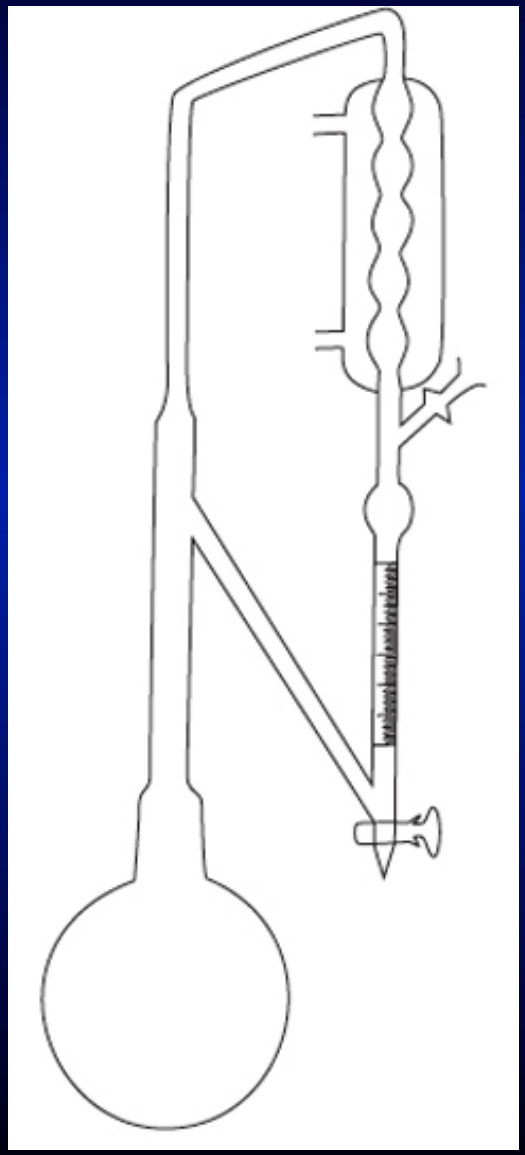
La distillation

La distillation

Antoine Chiris

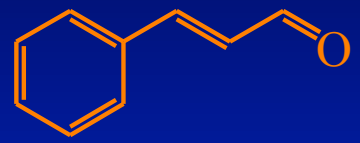
Alambic plus moderne à serpentin

Appareil type Clevenger

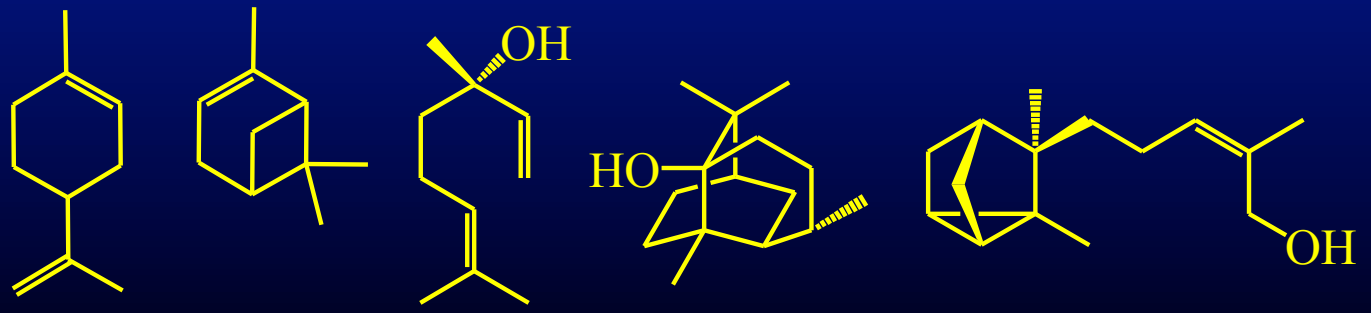


Les huiles essentielles

Phénylpropanoïdes :



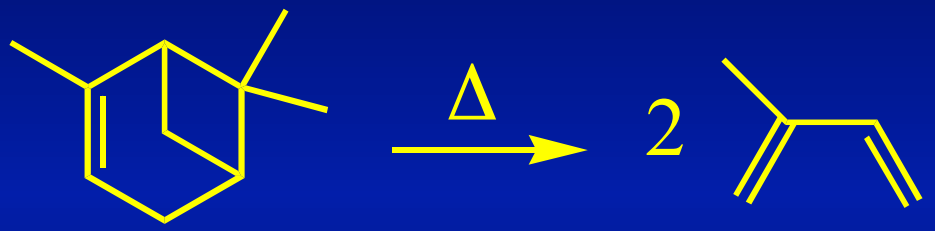
Terpènes et terpénoïdes :



Les terpénoïdes

1887 : « règle de l'isoprène » (Wallach)

Pyrolyse de l'α-pinène

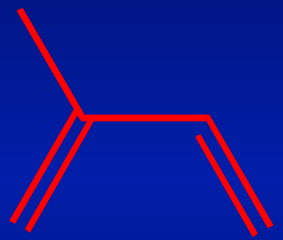


Unité isoprénique

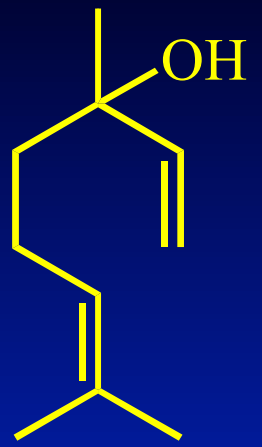
Diels-Alder

Limonène

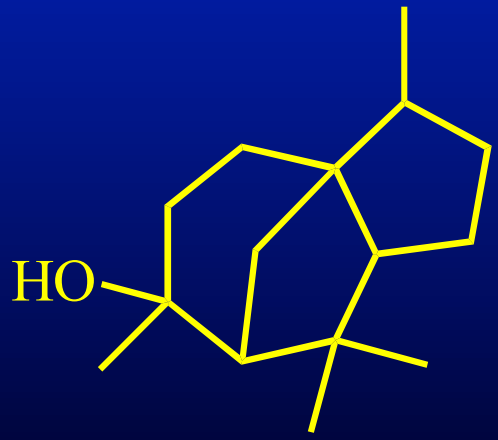
camphre



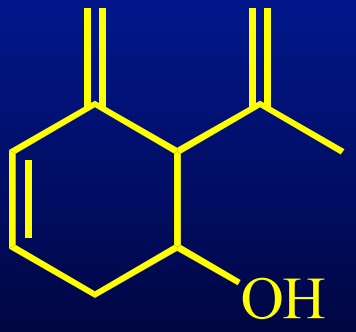
isoprene



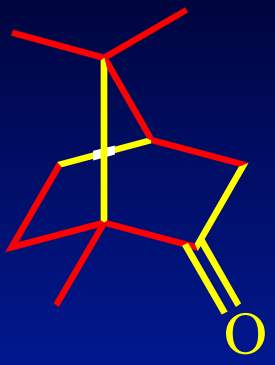
linalol



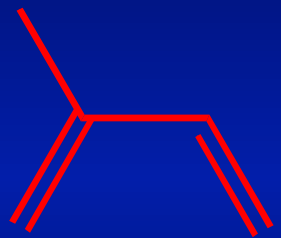
cedrol



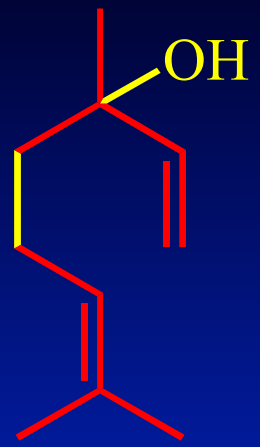
carquejol



camphre

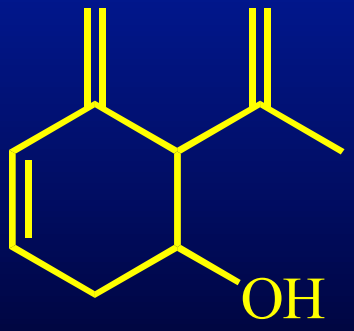


isoprene



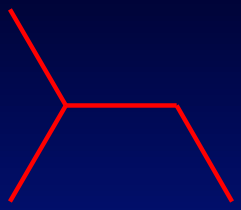
linalol

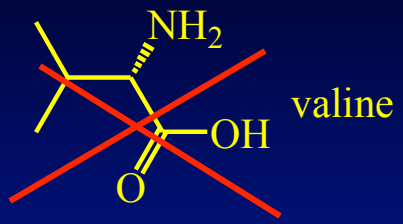
cedrol



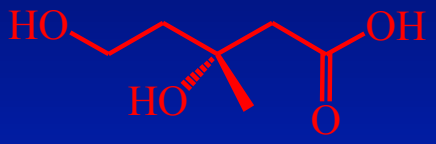
carquejol

La biosynthèse des terpénoïdes

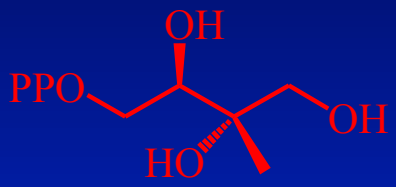




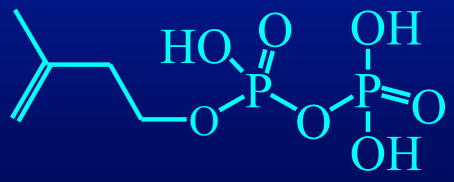
valine



Acide mévalonique

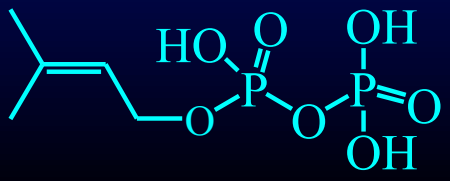


Méthylérythritol phosphate



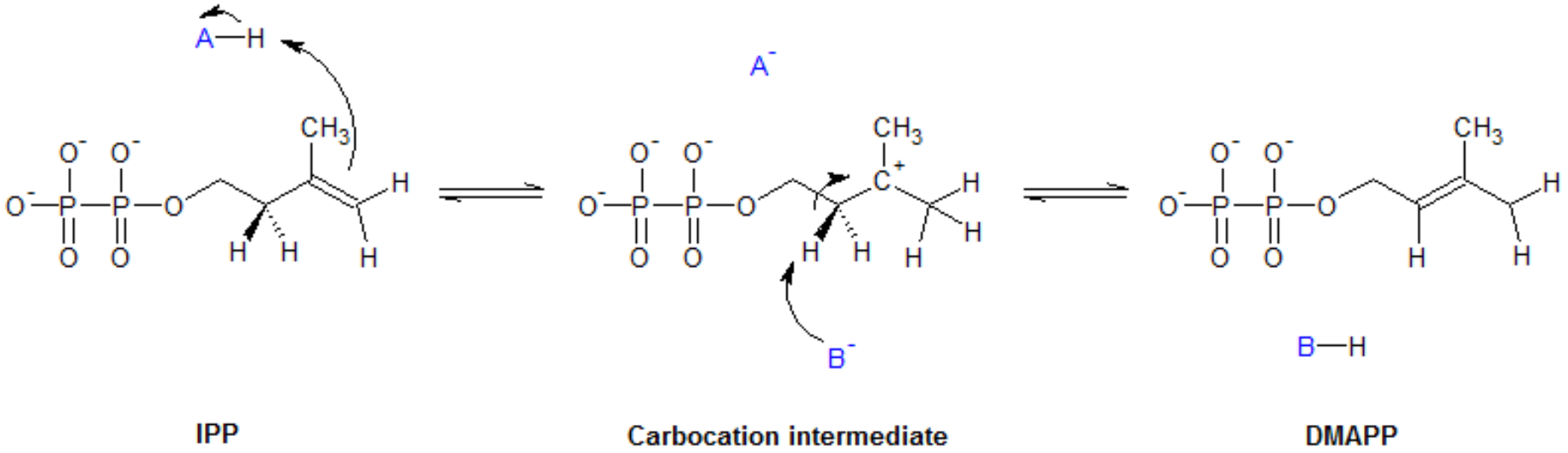
Isopentényl pyrophosphate
(IPP)

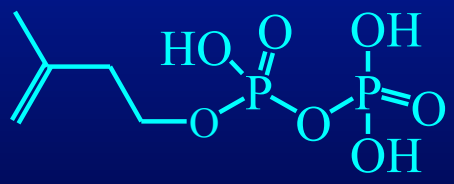
Isomérisation



Diméthylallyl pyrophosphate
(DMAPP)

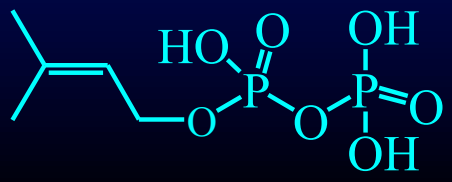
La biosynthèse des terpénoïdes





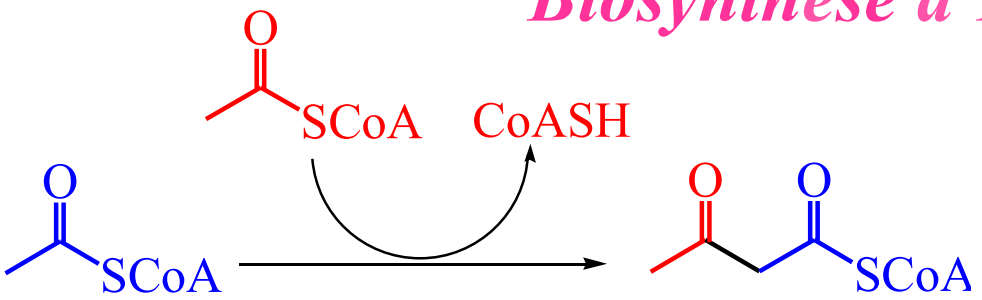
Isopentényl pyrophosphate
(IPP)

Isomérisation

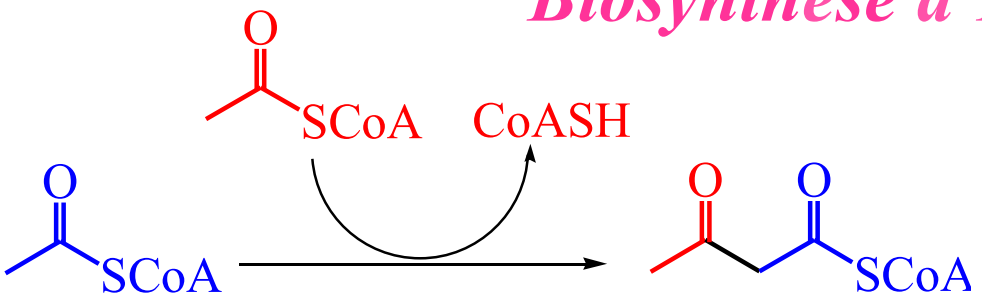


Diméthylallyl pyrophosphate
(DMAPP)

Biosynthèse d'IPP & DMAPP

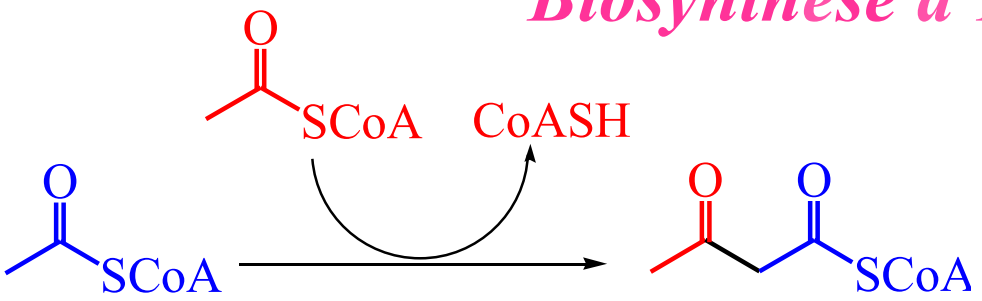


Biosynthèse d'IPP & DMAPP

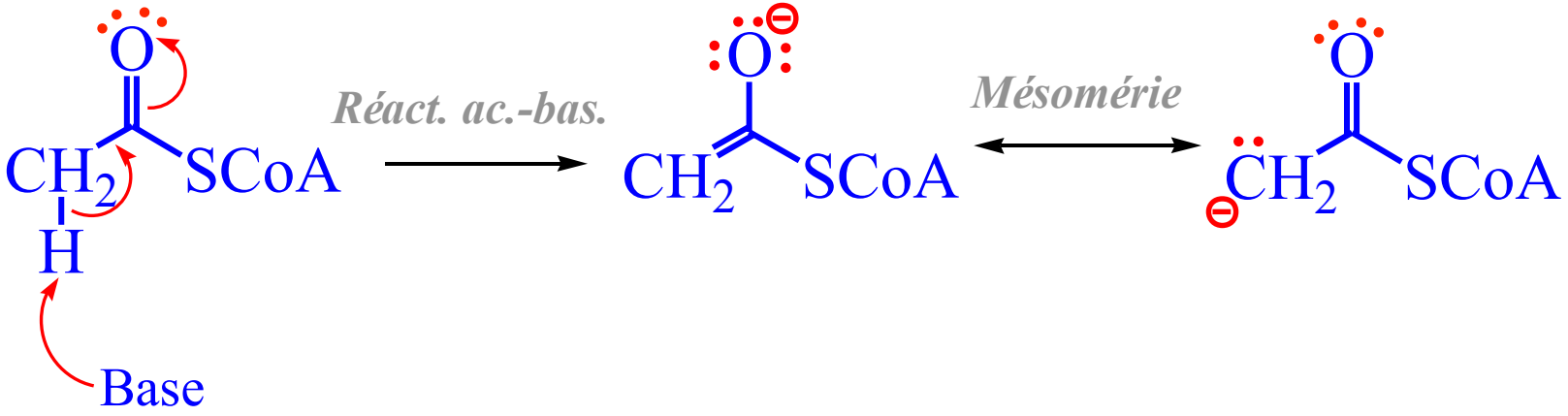


Condensation de Claisen

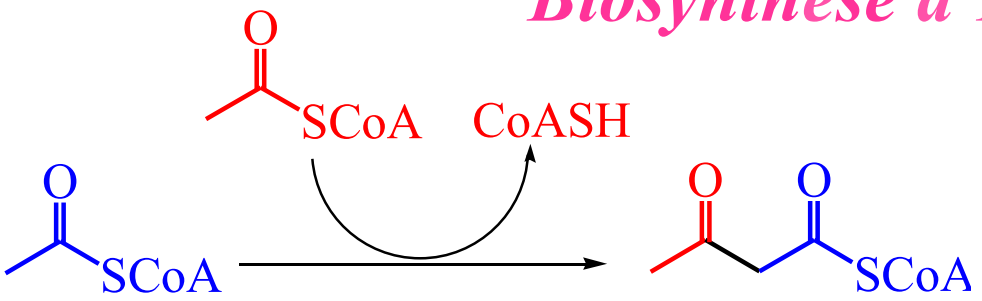
Biosynthèse d'IPP & DMAPP



Condensation de Claisen

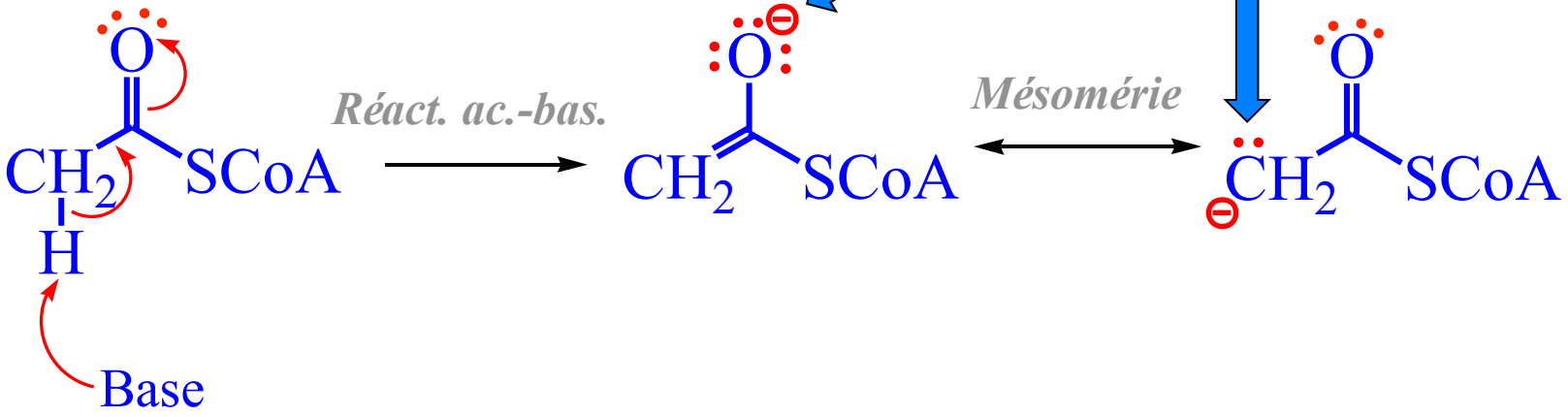


Biosynthèse d'IPP & DMAPP

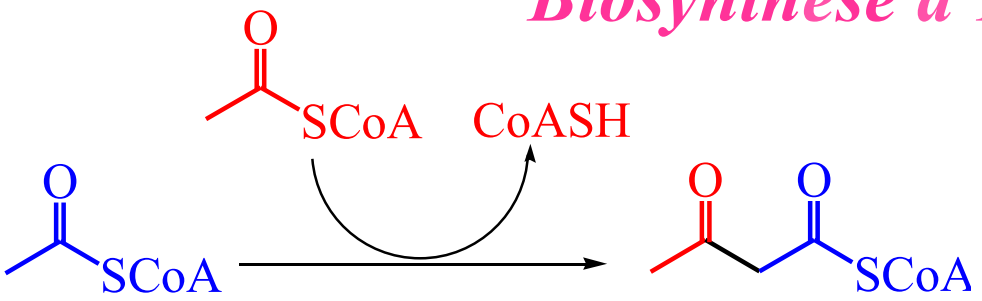


Condensation de Claisen

Sites nucléophiles

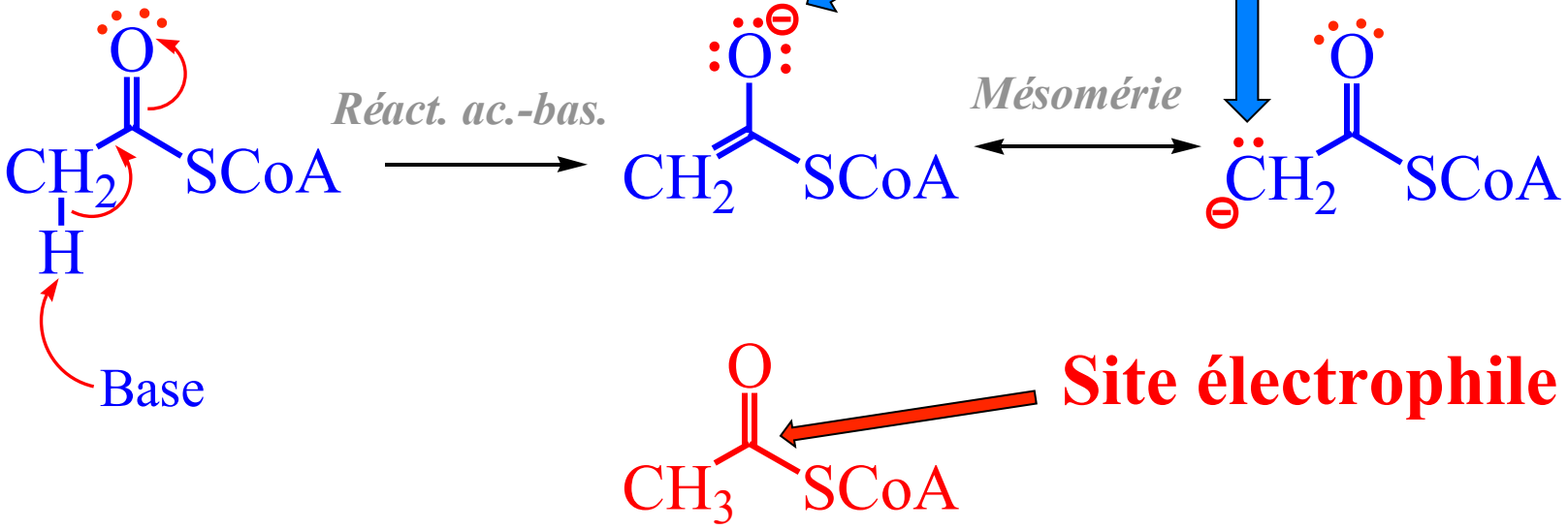


Biosynthèse d'IPP & DMAPP



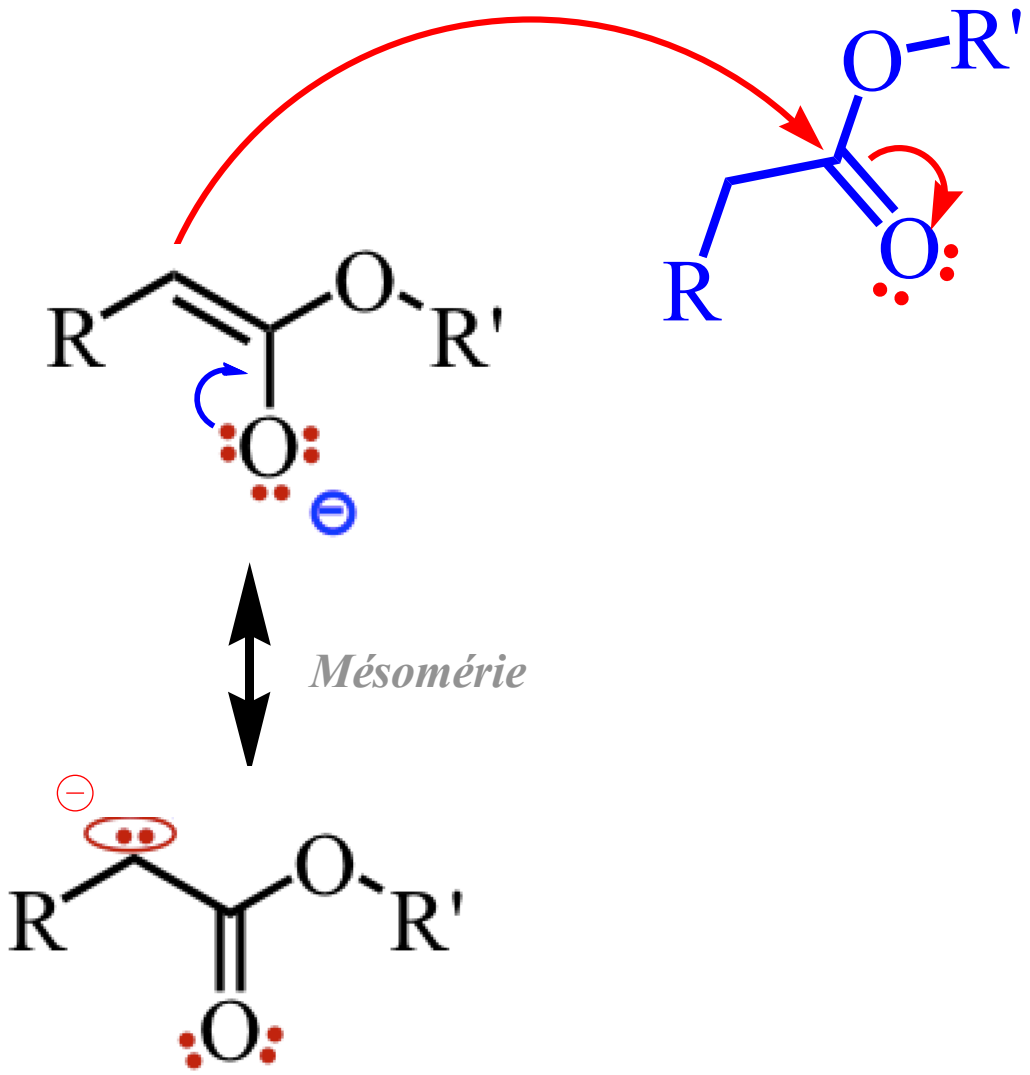
Condensation de Claisen

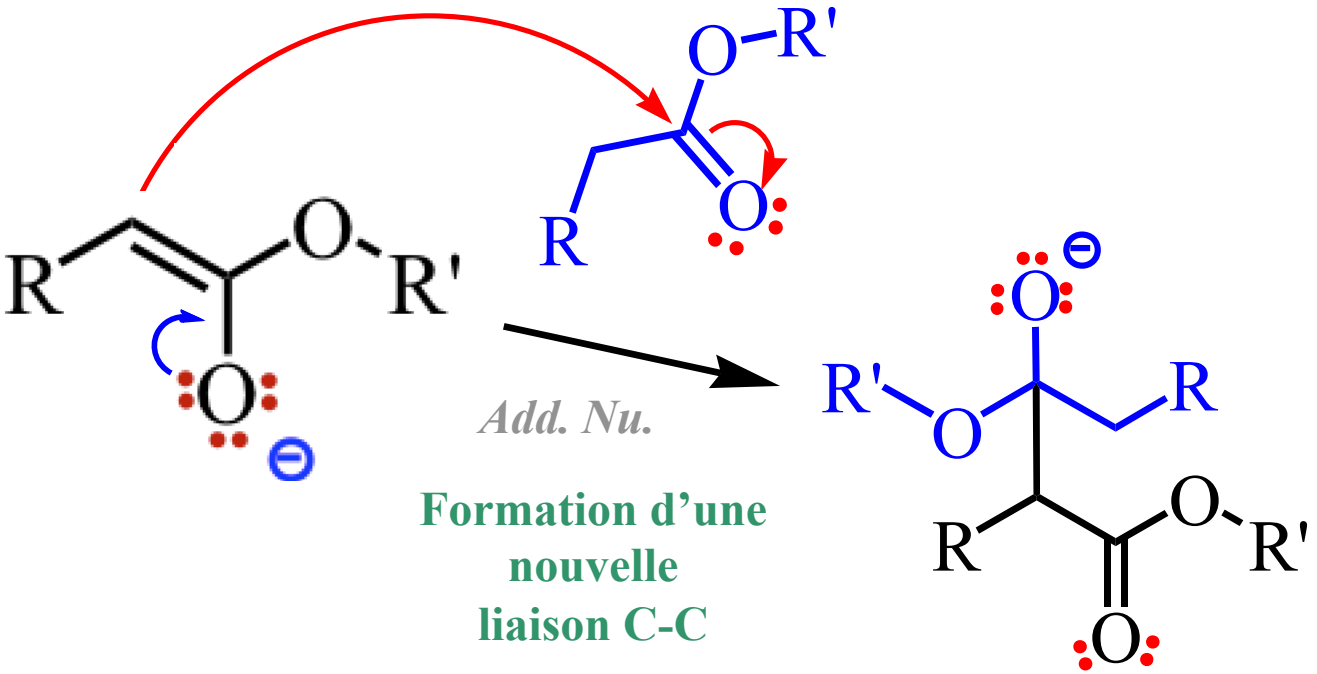
Sites nucléophiles

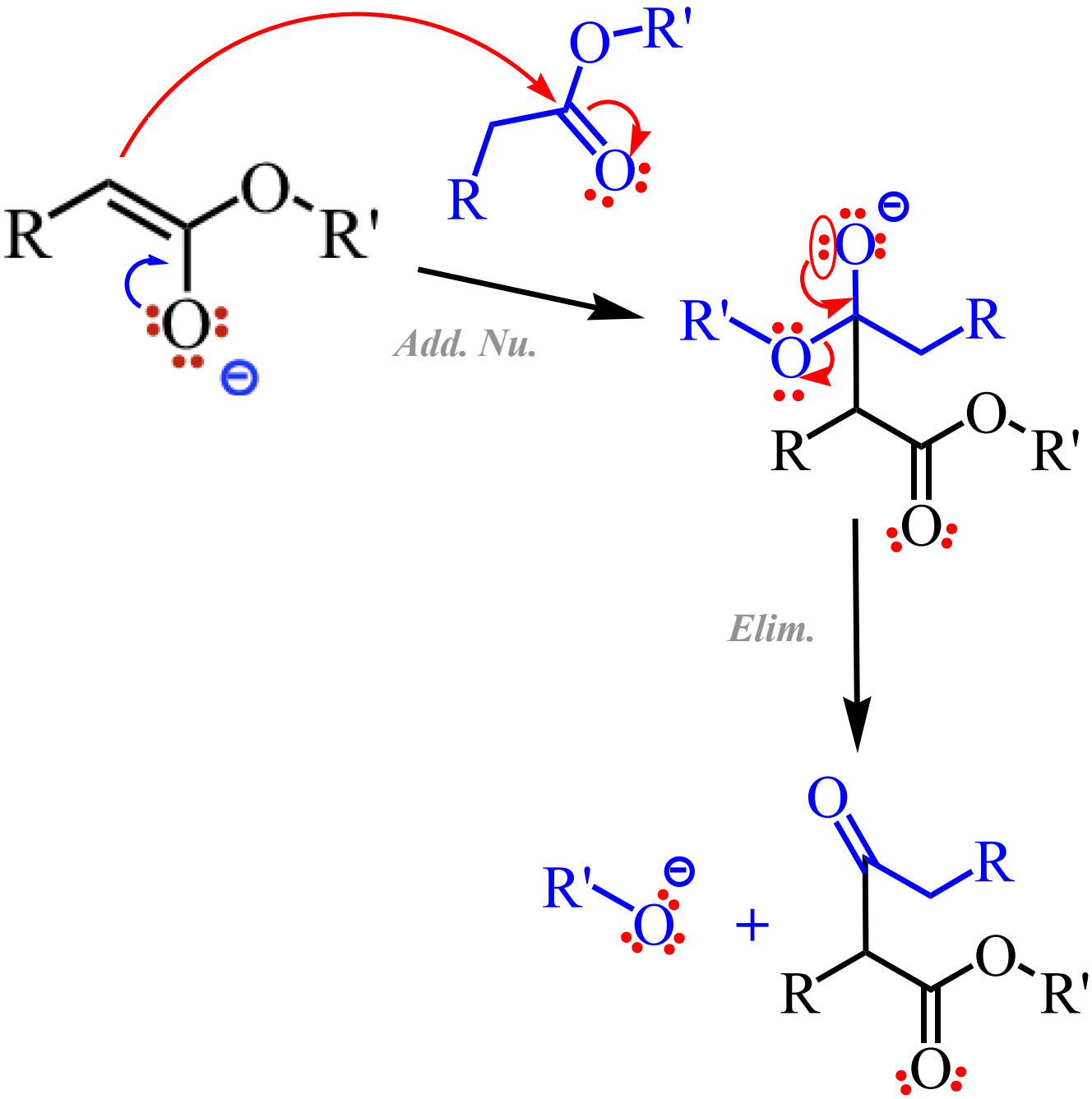


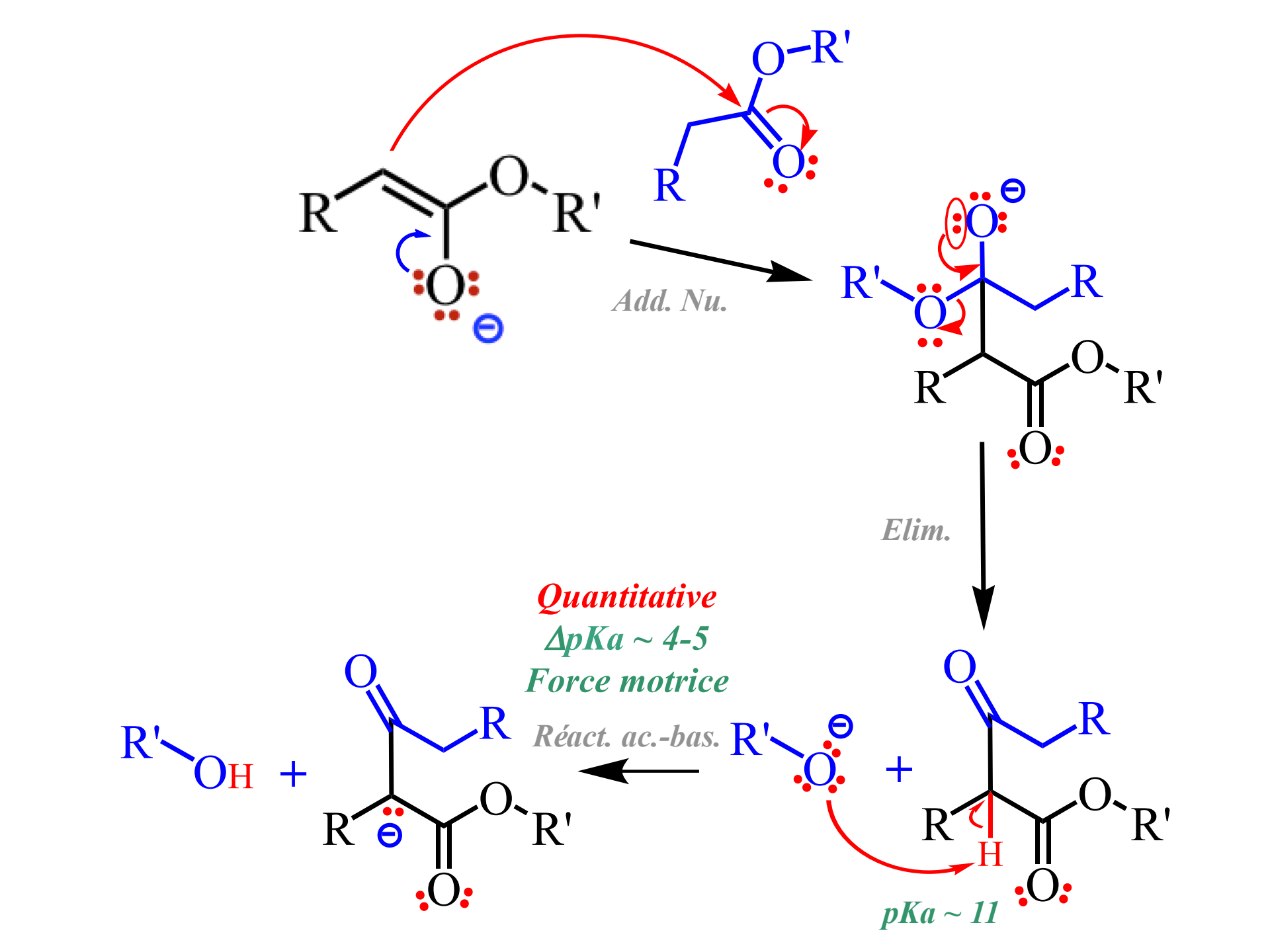
Site électrophile

Propriétés des énolates d'ester :
Condensations de Claisen / Dieckmann

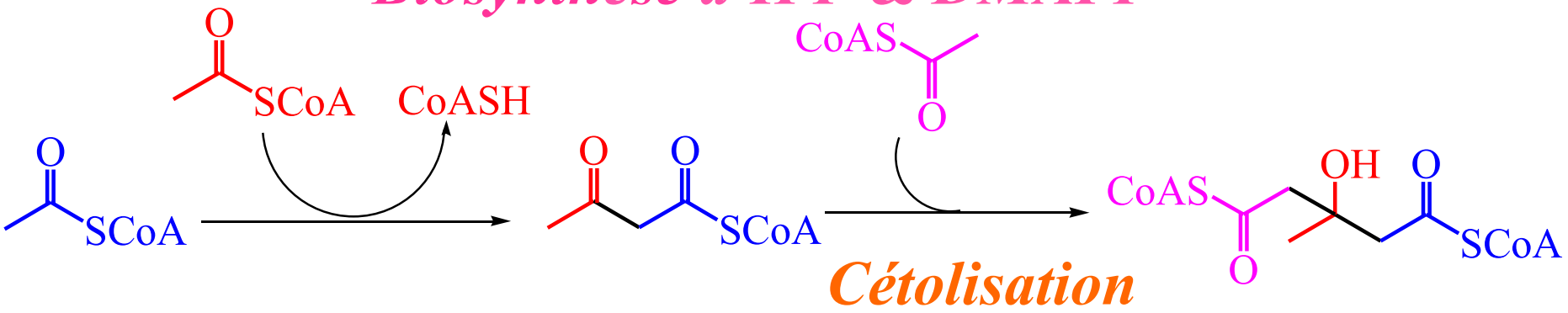



R
O
R'
O
R
O
R'
O
Add. Nu.
Formation d'une
nouvelle
liaison C-C
R'
O
R
O
R
O
R'
O


R
O
R'
O
R
O
R'
Add. Nu.
R'
O
R
O
R
O
R'
O
Elim.
R'
O
+
O
R
R
O
R'
O

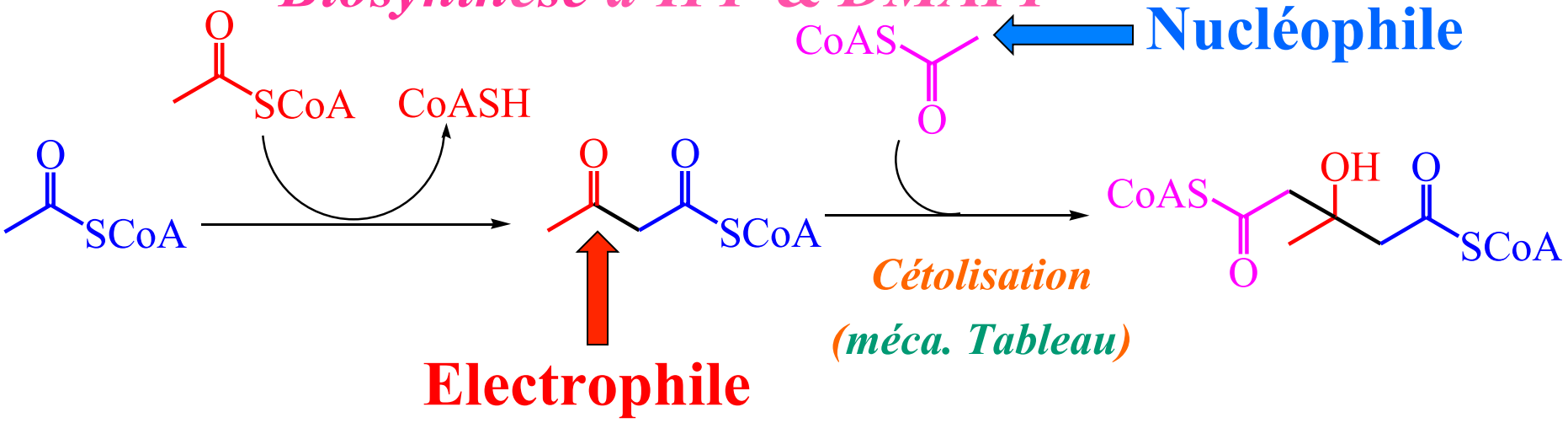

Add. Nu.
Elim.
Quantitative
ΔpKa ~ 4-5
Force motrice
Réact. ac.-bas.
pKa ~ 11

Biosynthèse d'IPP & DMAPP

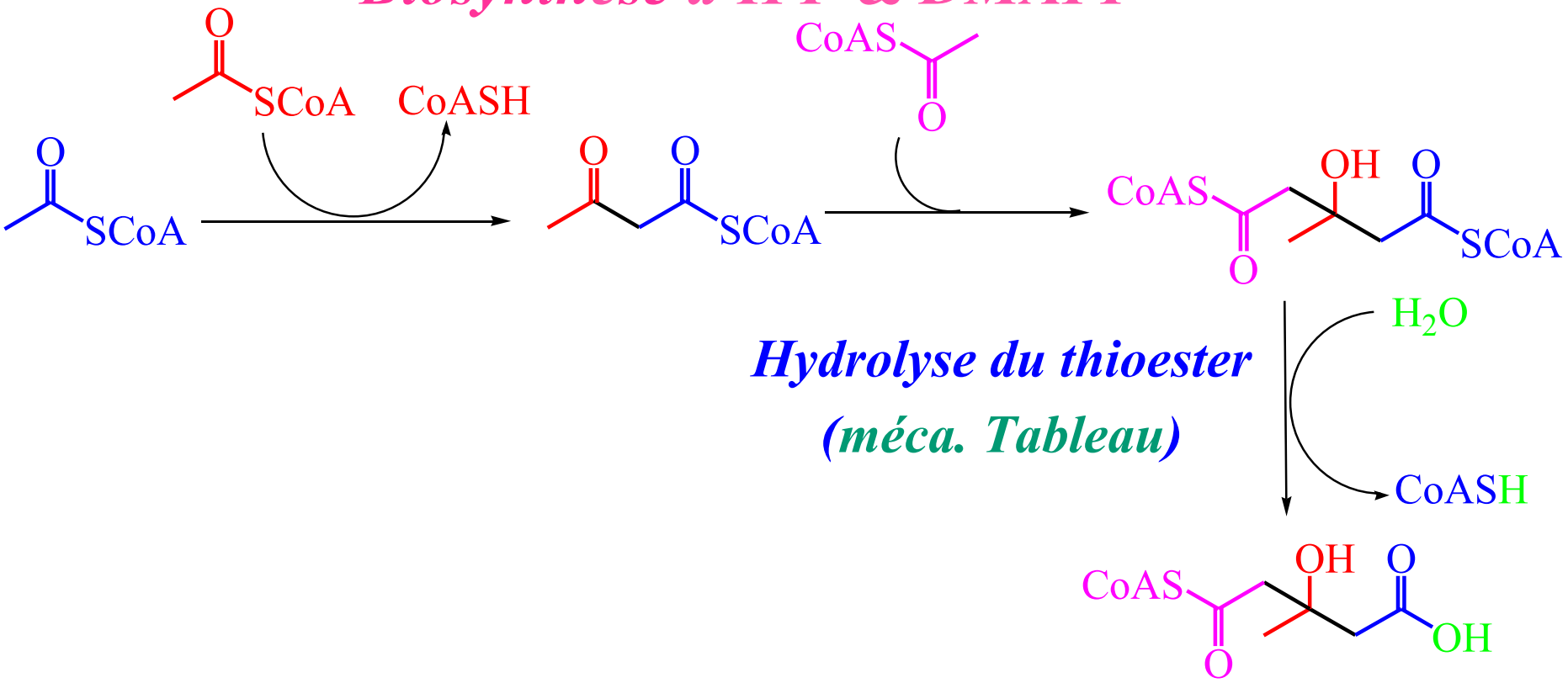


Cétolisation

Biosynthèse d'IPP & DMAPP

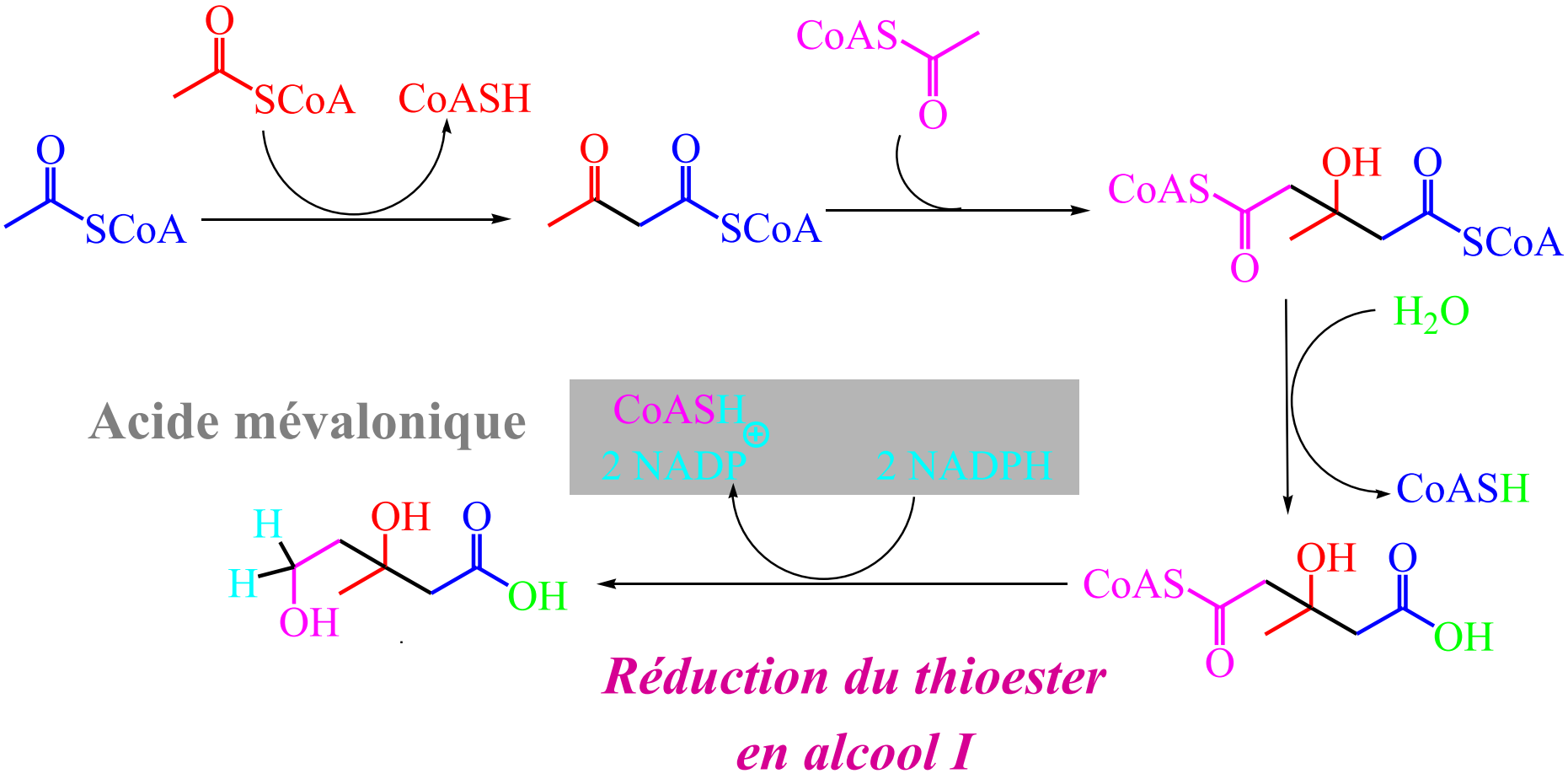


Biosynthèse d'IPP & DMAPP



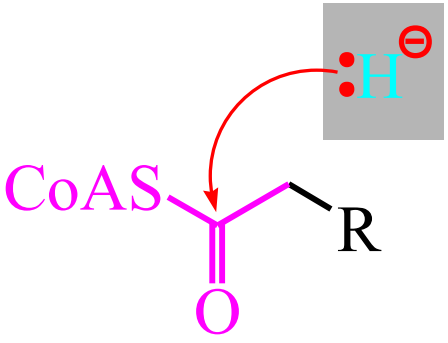
Hydrolyse du thioester

(méca. Tableau)

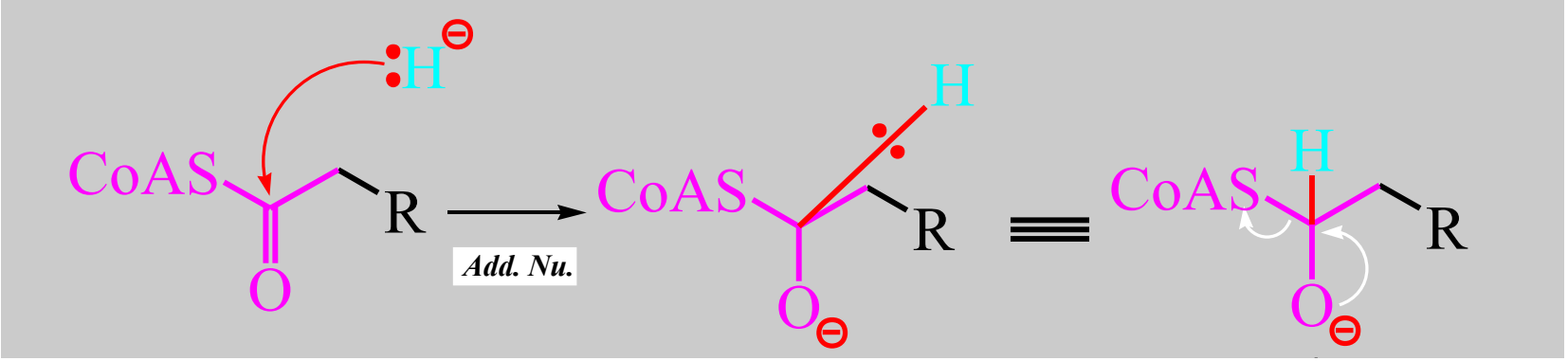


Réduction du thioester en alcool I

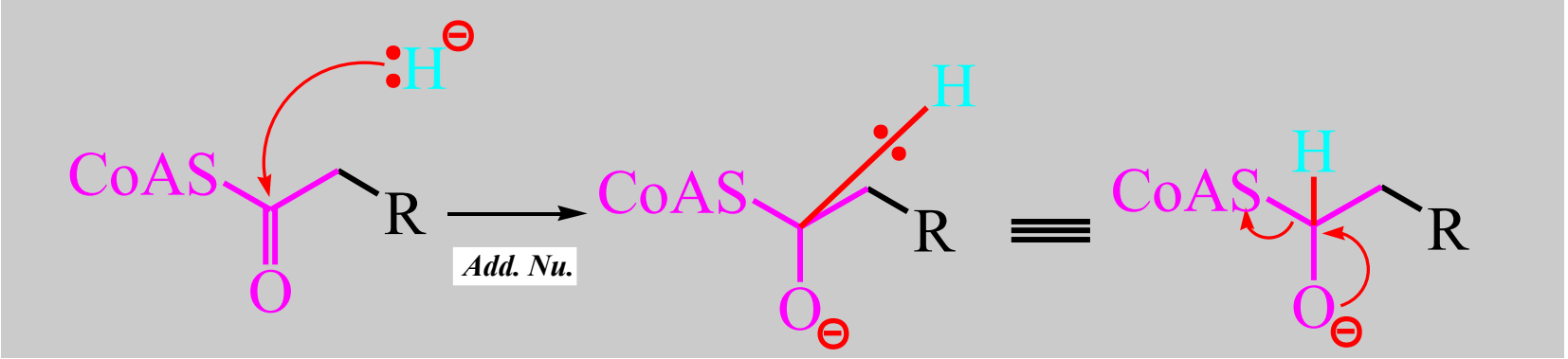
Réduction du Thioester en Alcool I



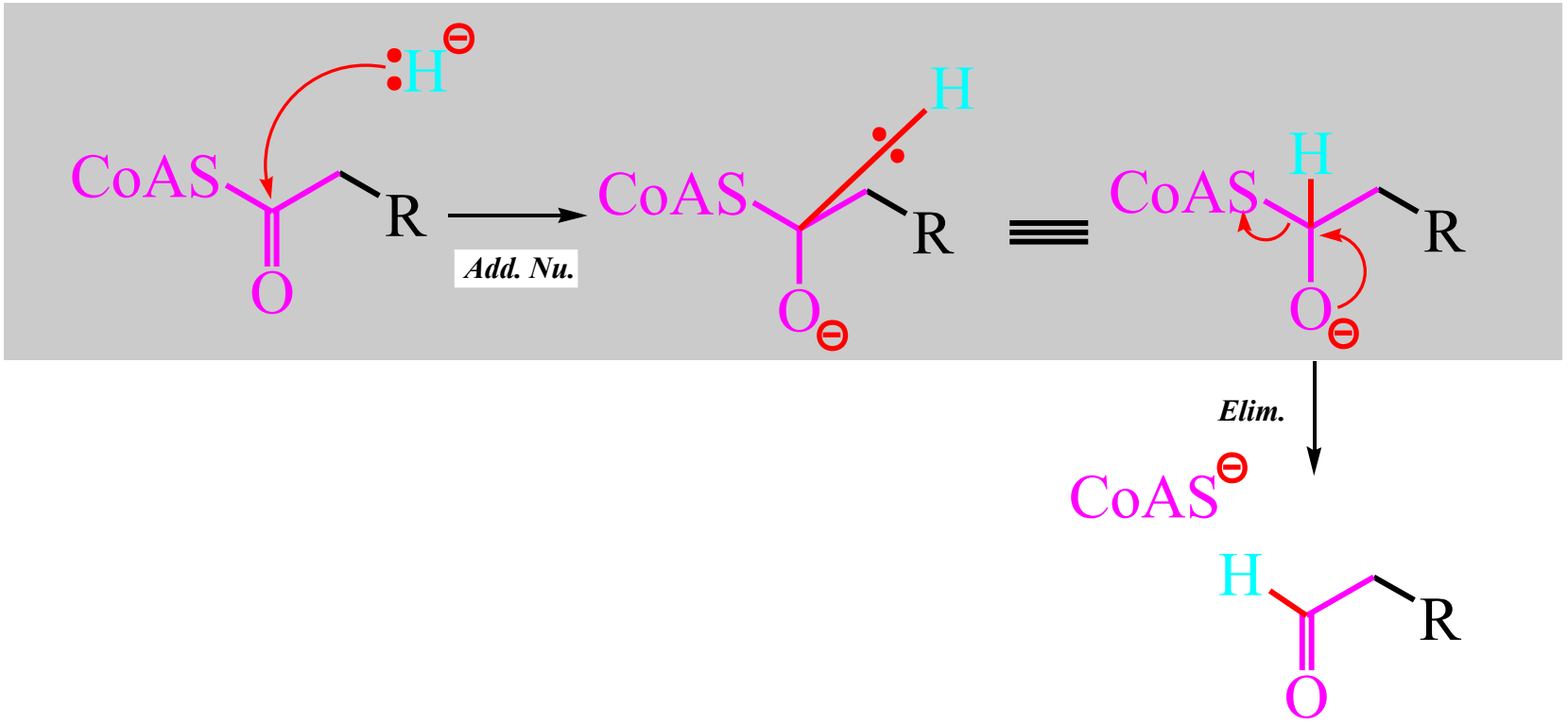
Réduction du Thioester en Alcool I



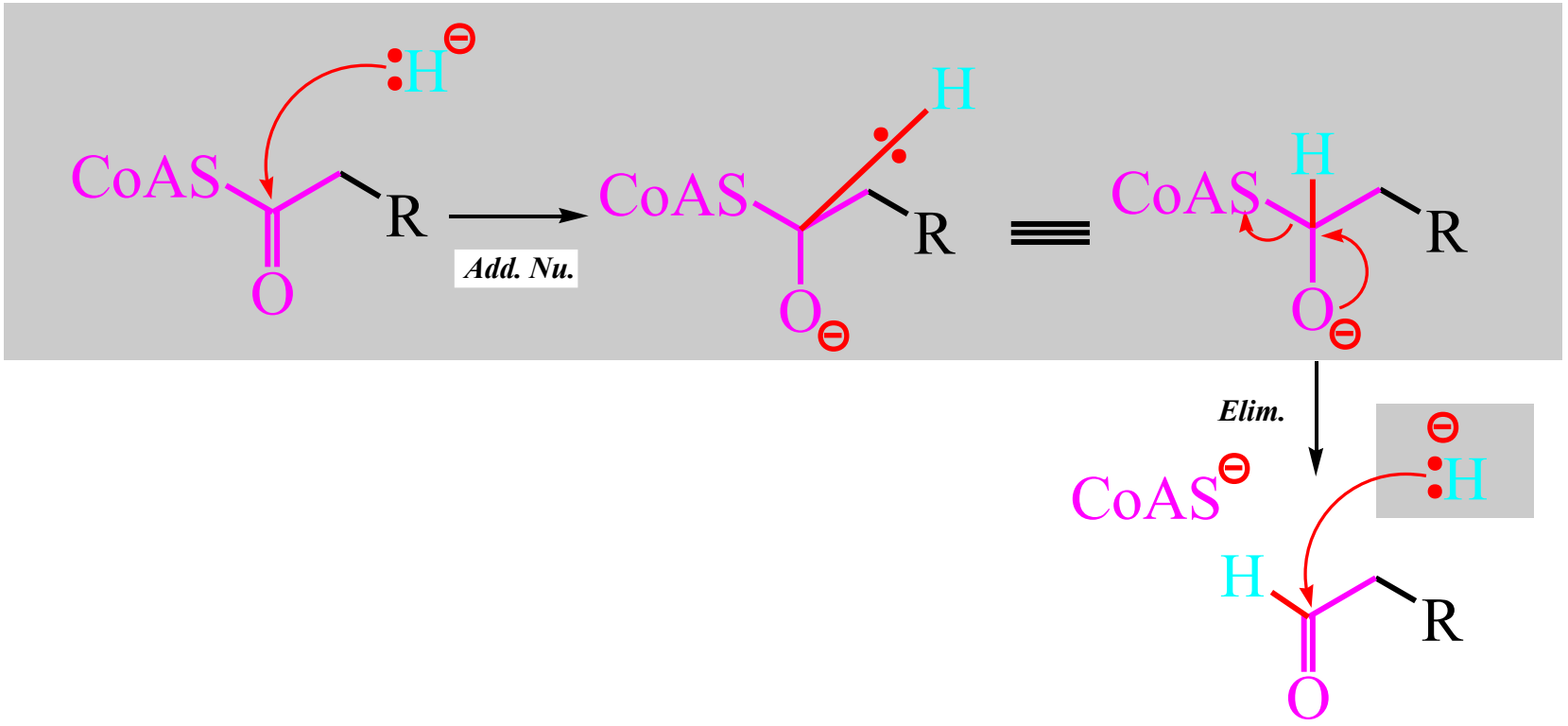
Réduction du Thioester en Alcool I



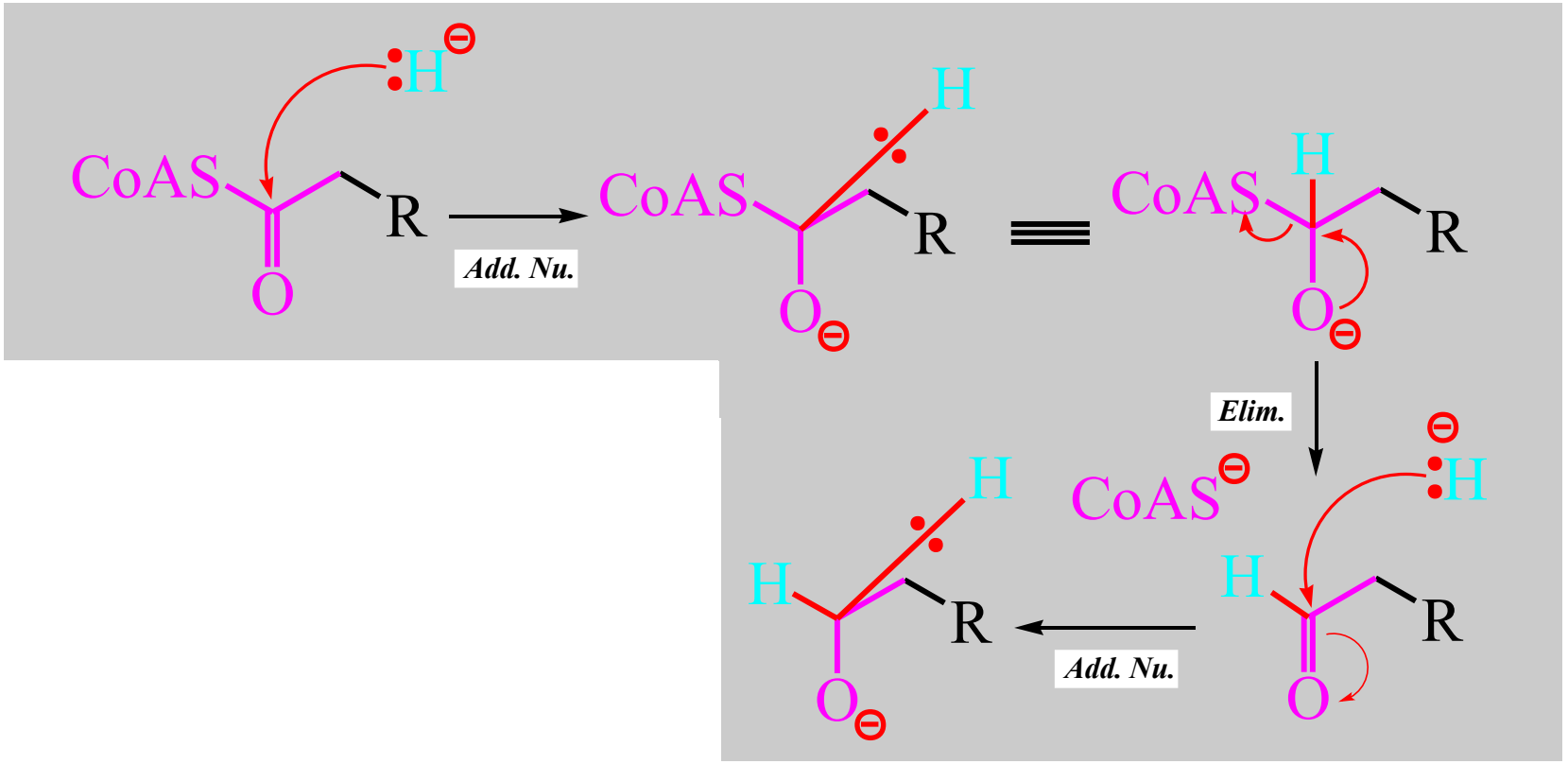
Réduction du Thioester en Alcool I



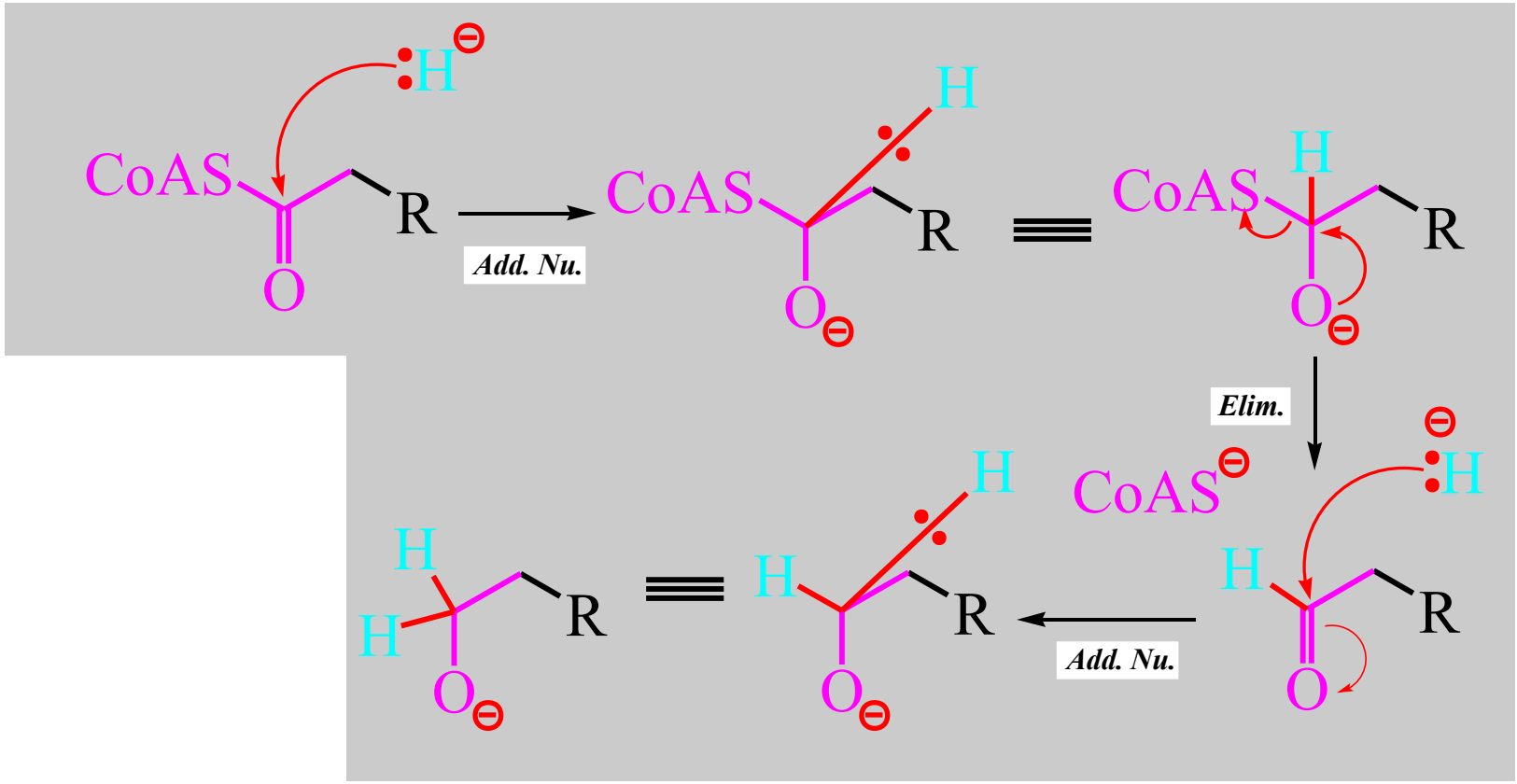
Réduction du Thioester en Alcool I



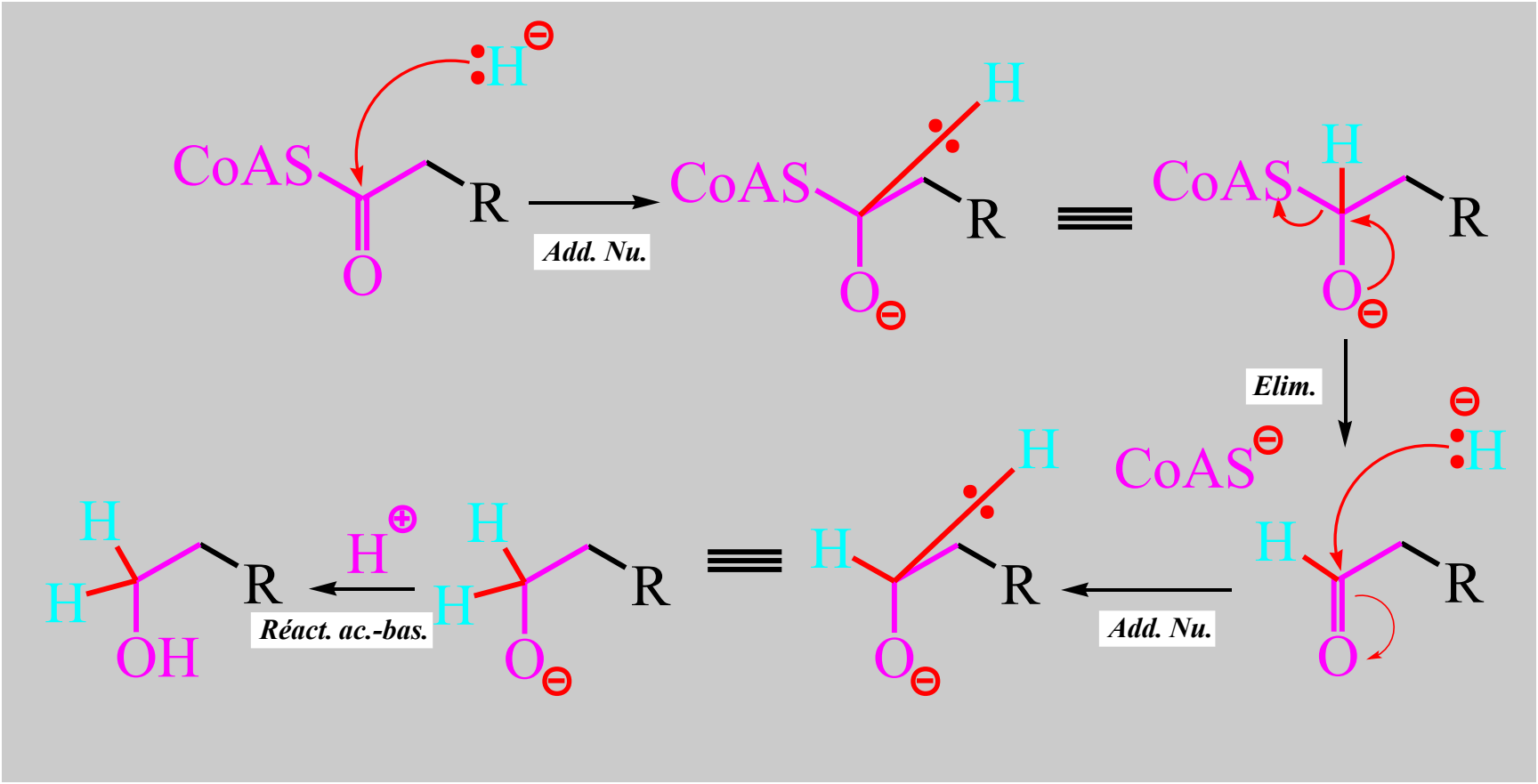
Réduction du Thioester en Alcool I



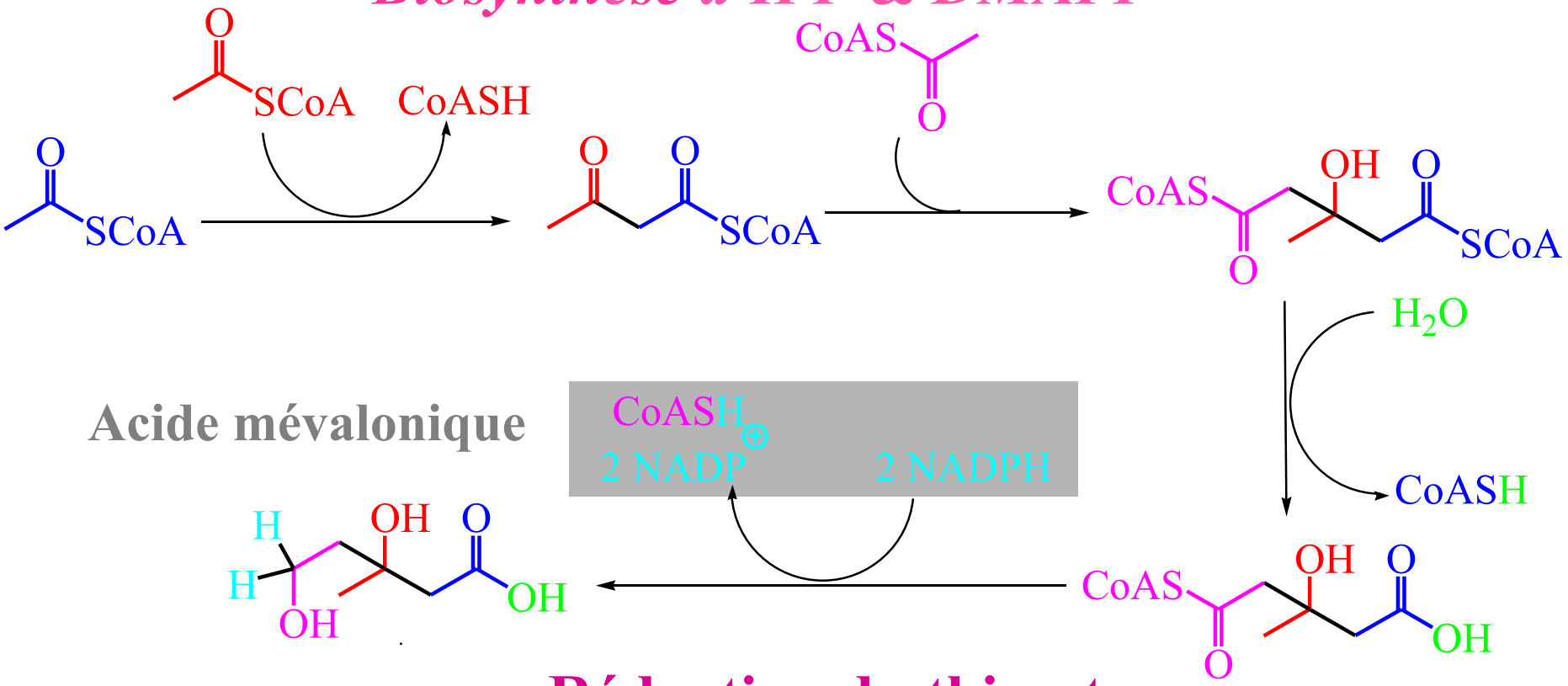
Réduction du Thioester en Alcool I



Réduction du Thioester en Alcool I

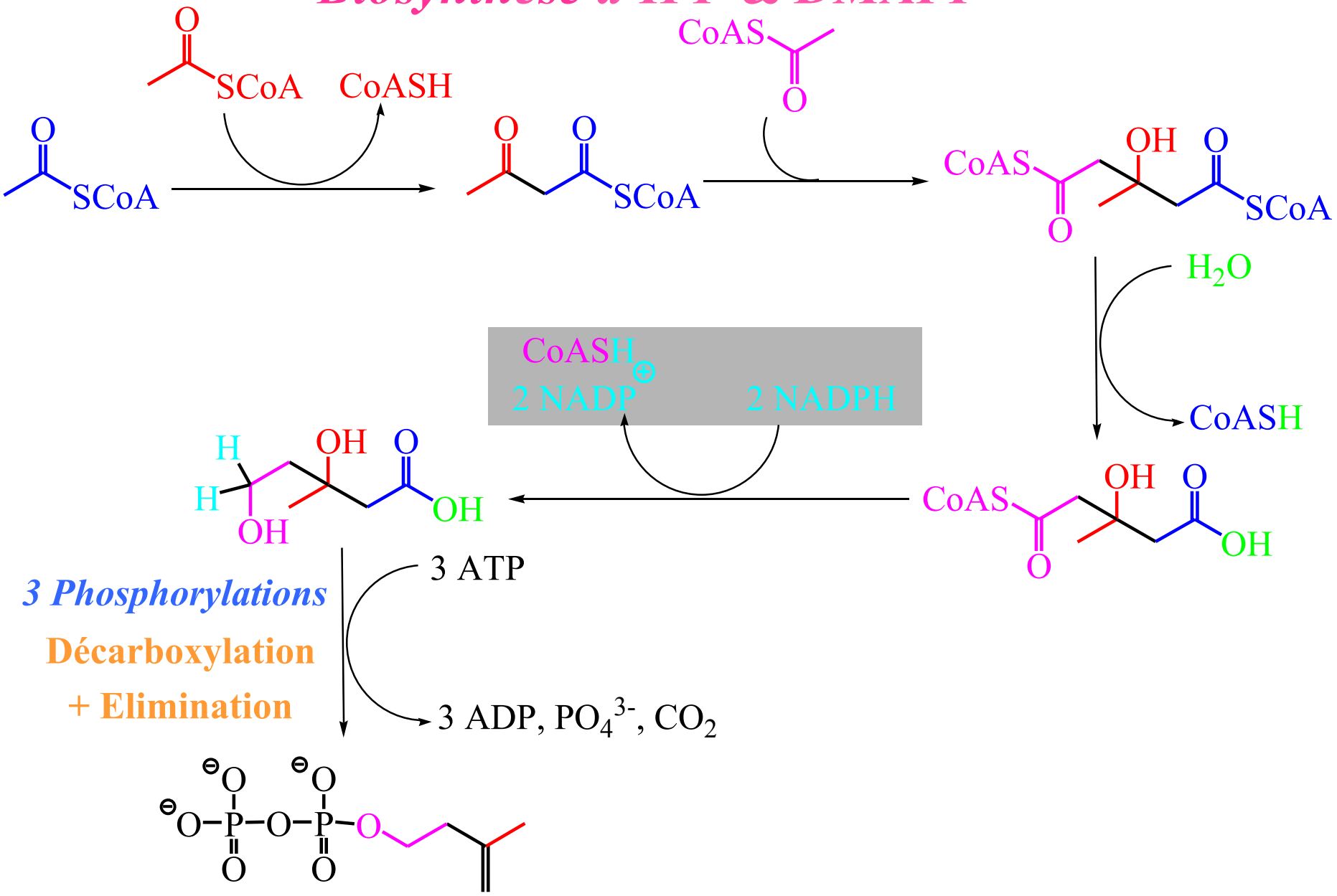


Biosynthèse d'IPP & DMAPP



Réduction du thioester en alcool I

Biosynthèse d'IPP & DMAPP



3 Phosphorylations

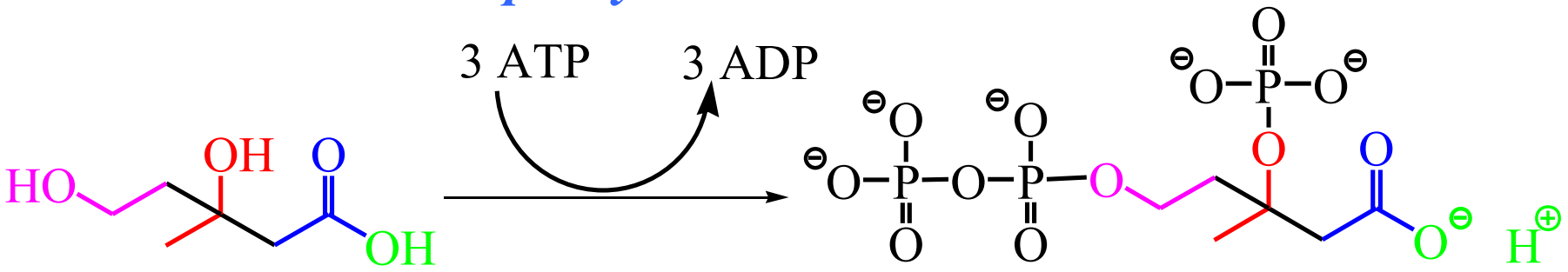
Décarboxylation

+ Elimination

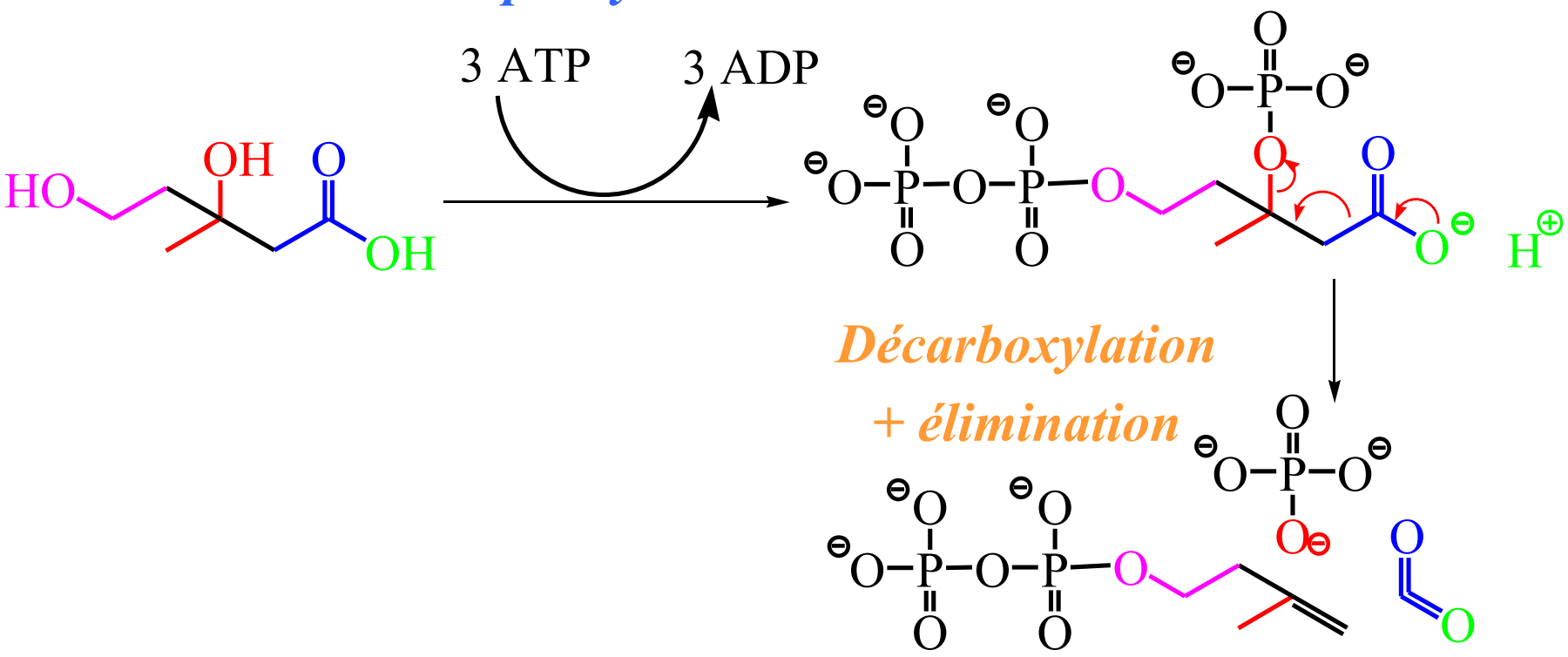
Isopentényl pyrophosphate (IPP)

Détails des Transformations

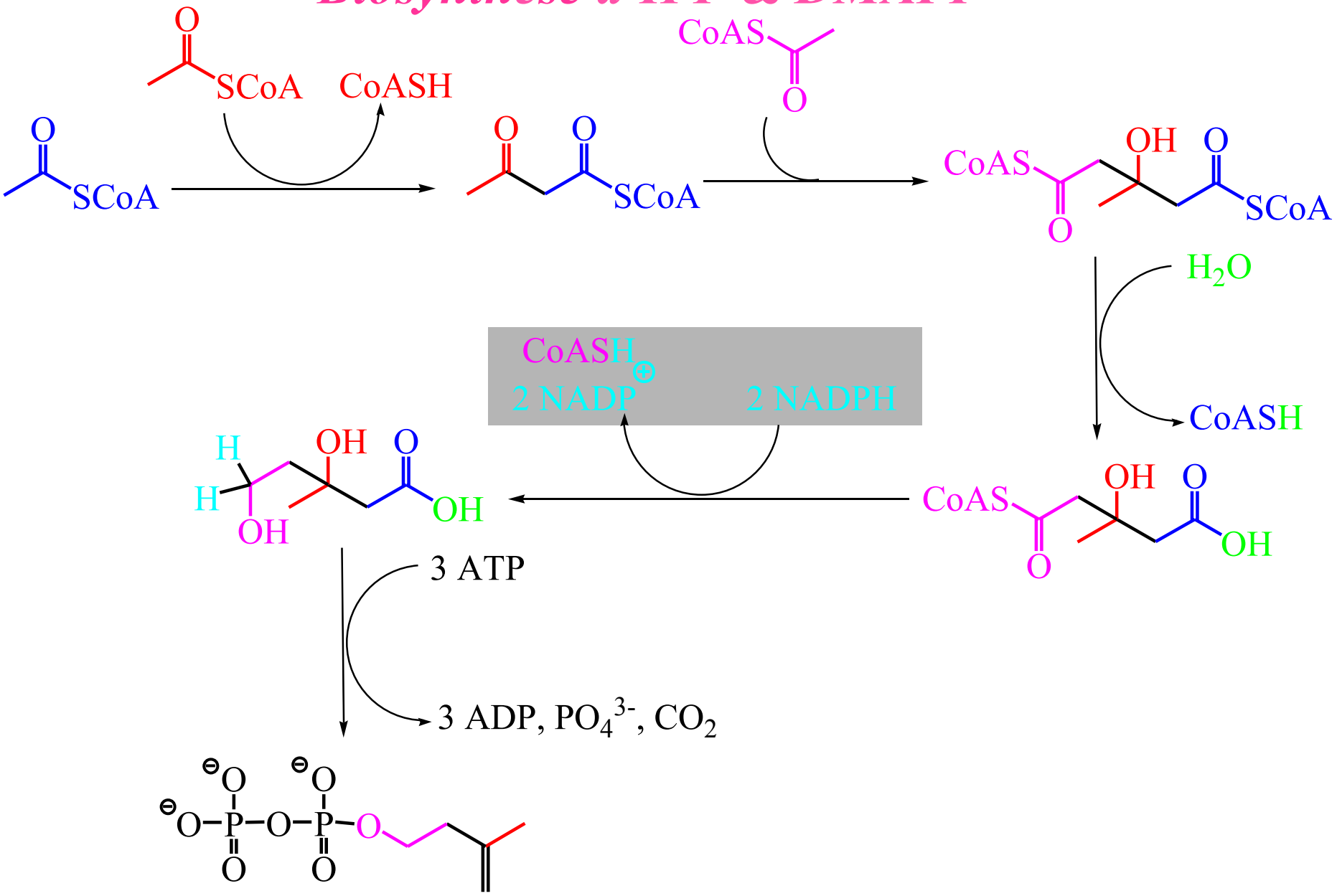
Phosphorylations 3x



Détails des Transformations

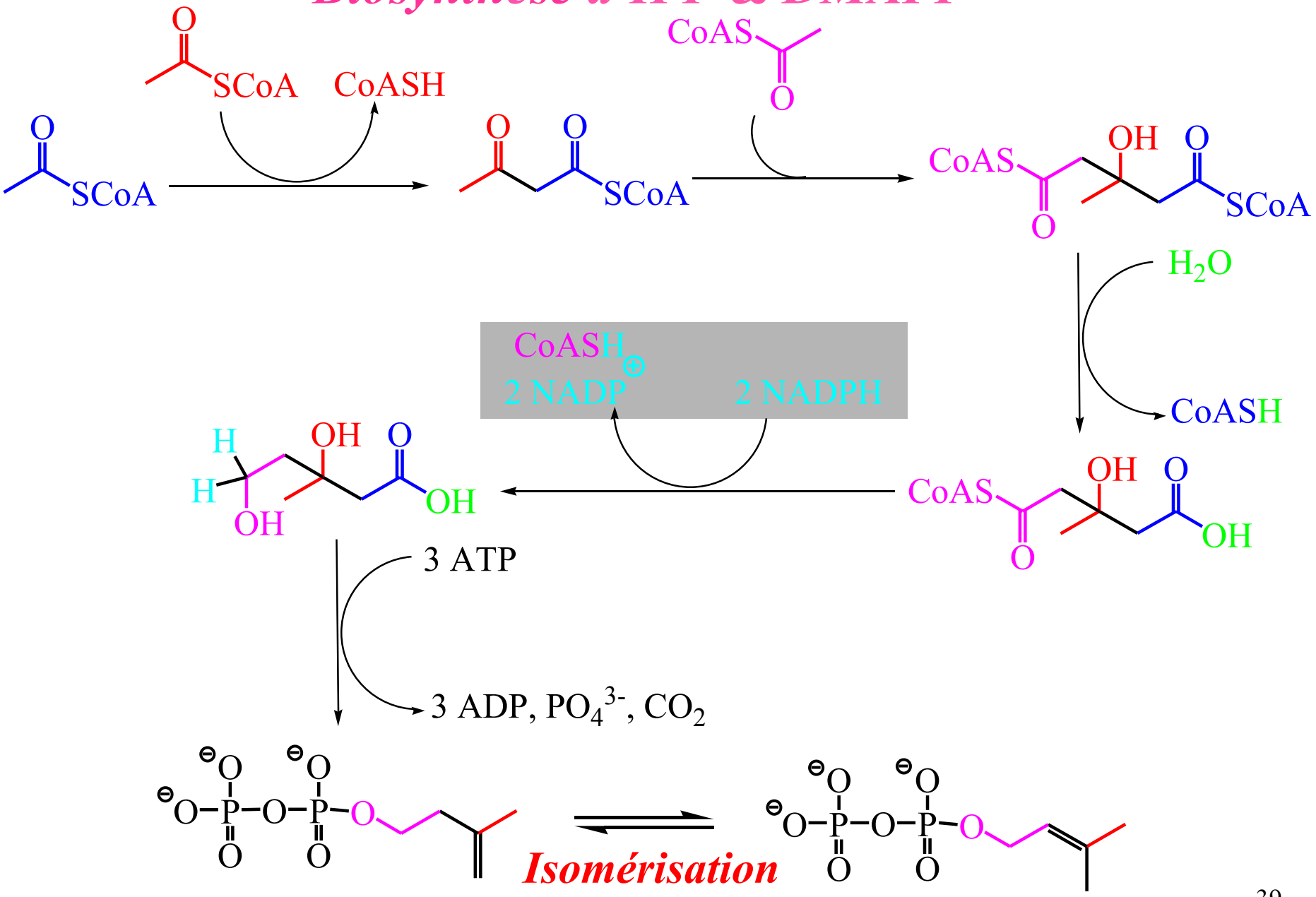


Biosynthèse d'IPP & DMAPP



Isopentényl pyrophosphate (IPP)

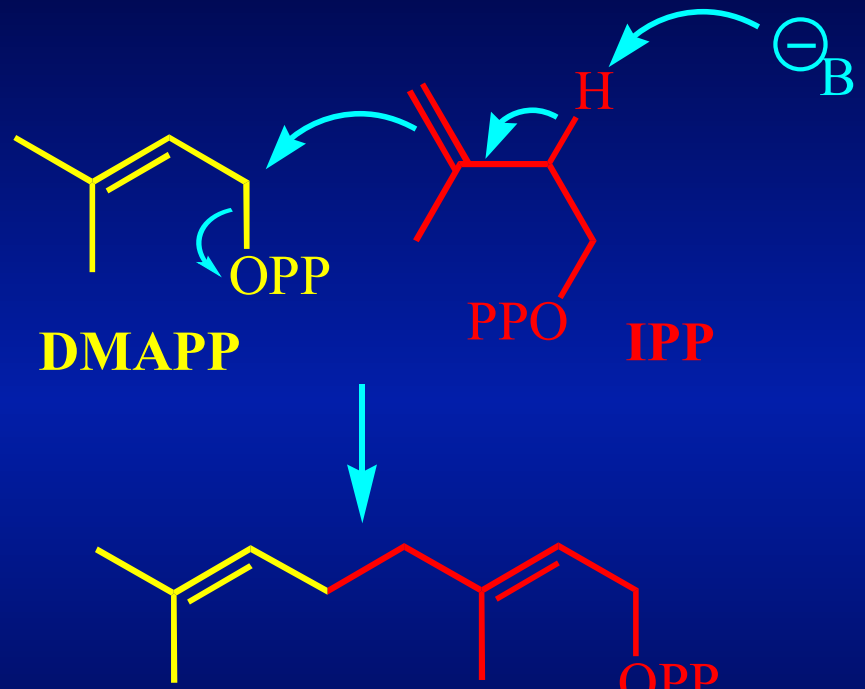
Biosynthèse d'IPP & DMAPP



Isopentényl pyrophosphate (IPP)

Dimethylallyl pyrophosphate (DMAPP)

La Biosynthèse des Monoterpénoïdes

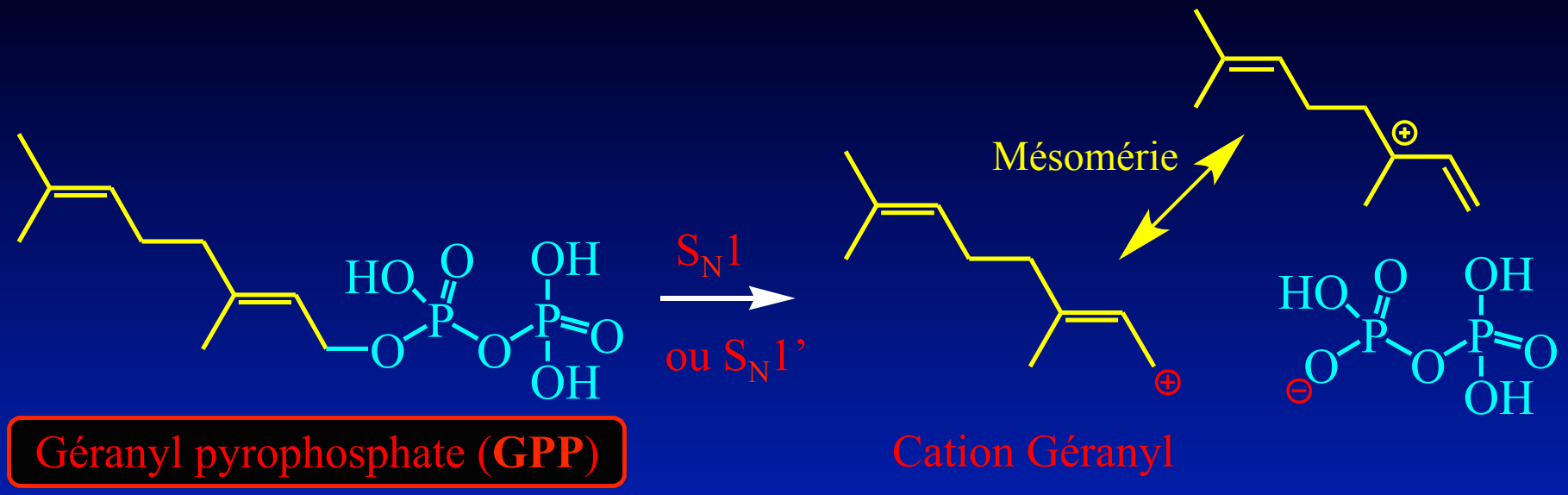


Géranyl pyrophosphate (**GPP**)

$(C_5H_8)_n$ / n = 2

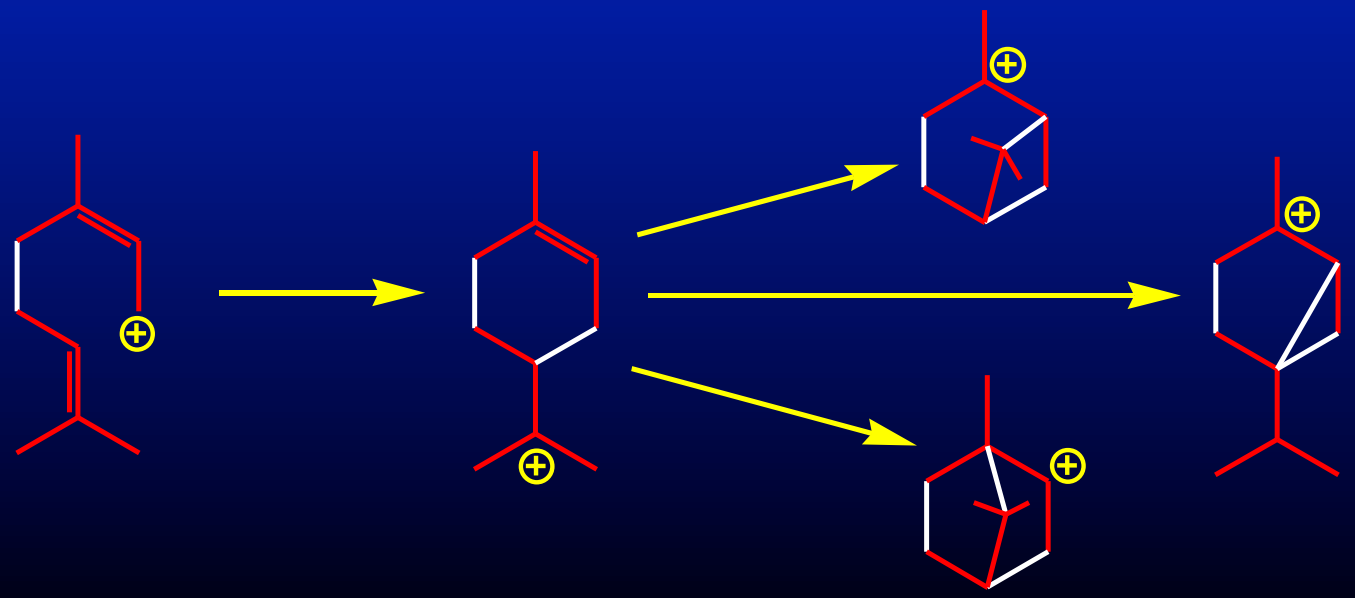
MONOTERPENOIDES

Biosynthèse des monoterpénoïdes :



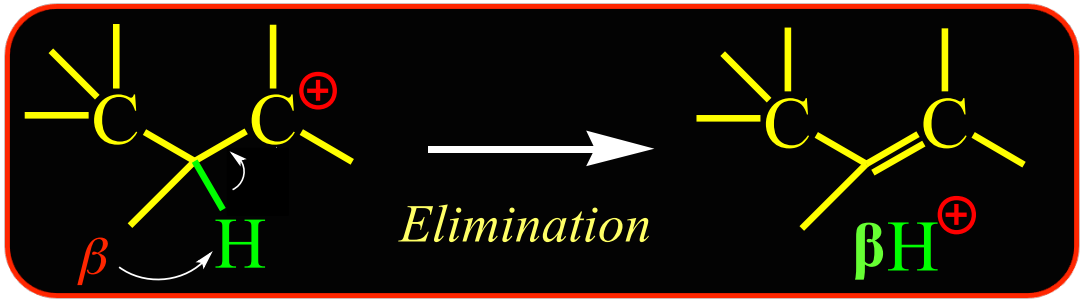
Géranyl pyrophosphate (**GPP**)

Cation Géranyl



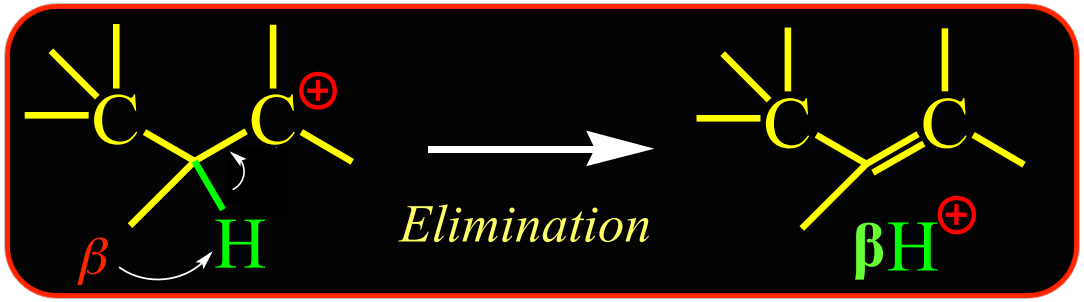
Réactions Fondamentales des Carbocations

1

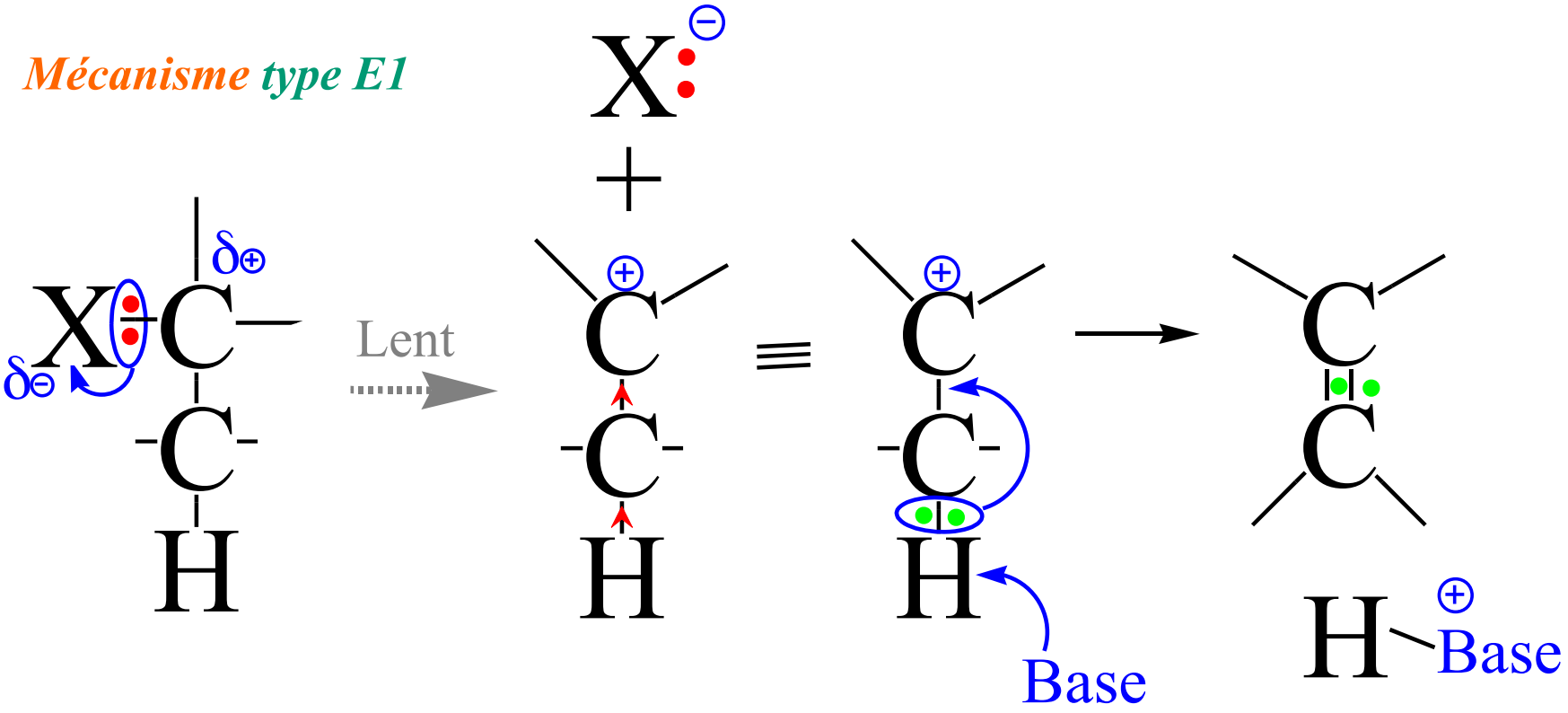


Réactions Fondamentales des Carbocations

1

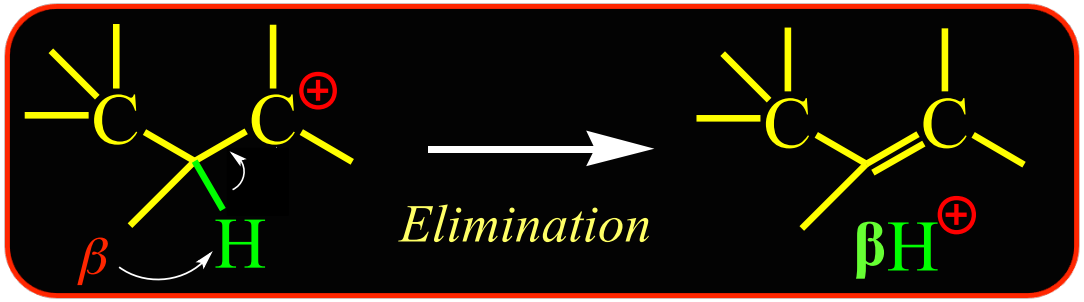


Mécanisme type E1



Réactions Fondamentales des Carbocations

1



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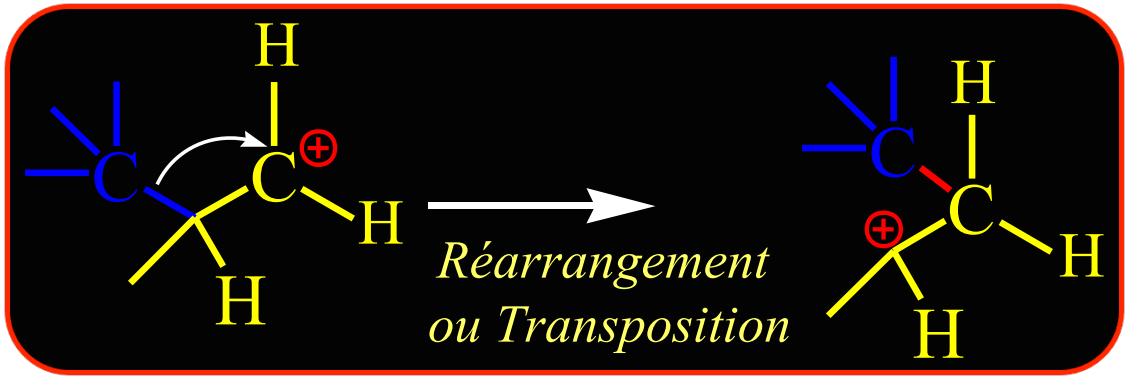
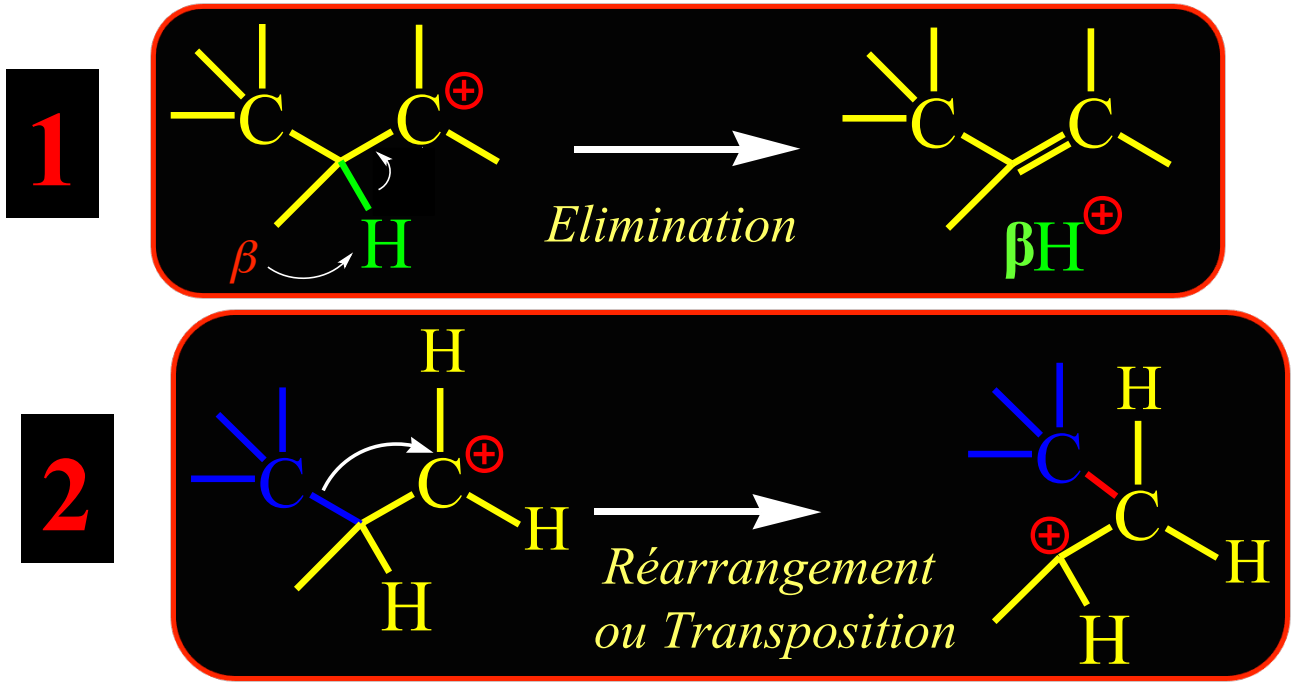
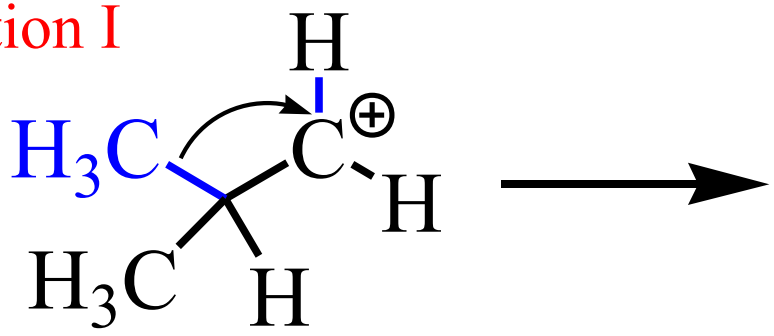


Réactions Fondamentales des Carbocations

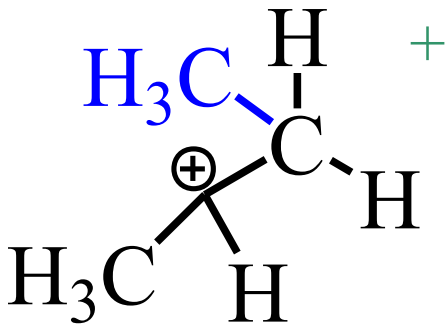


Carbocation I

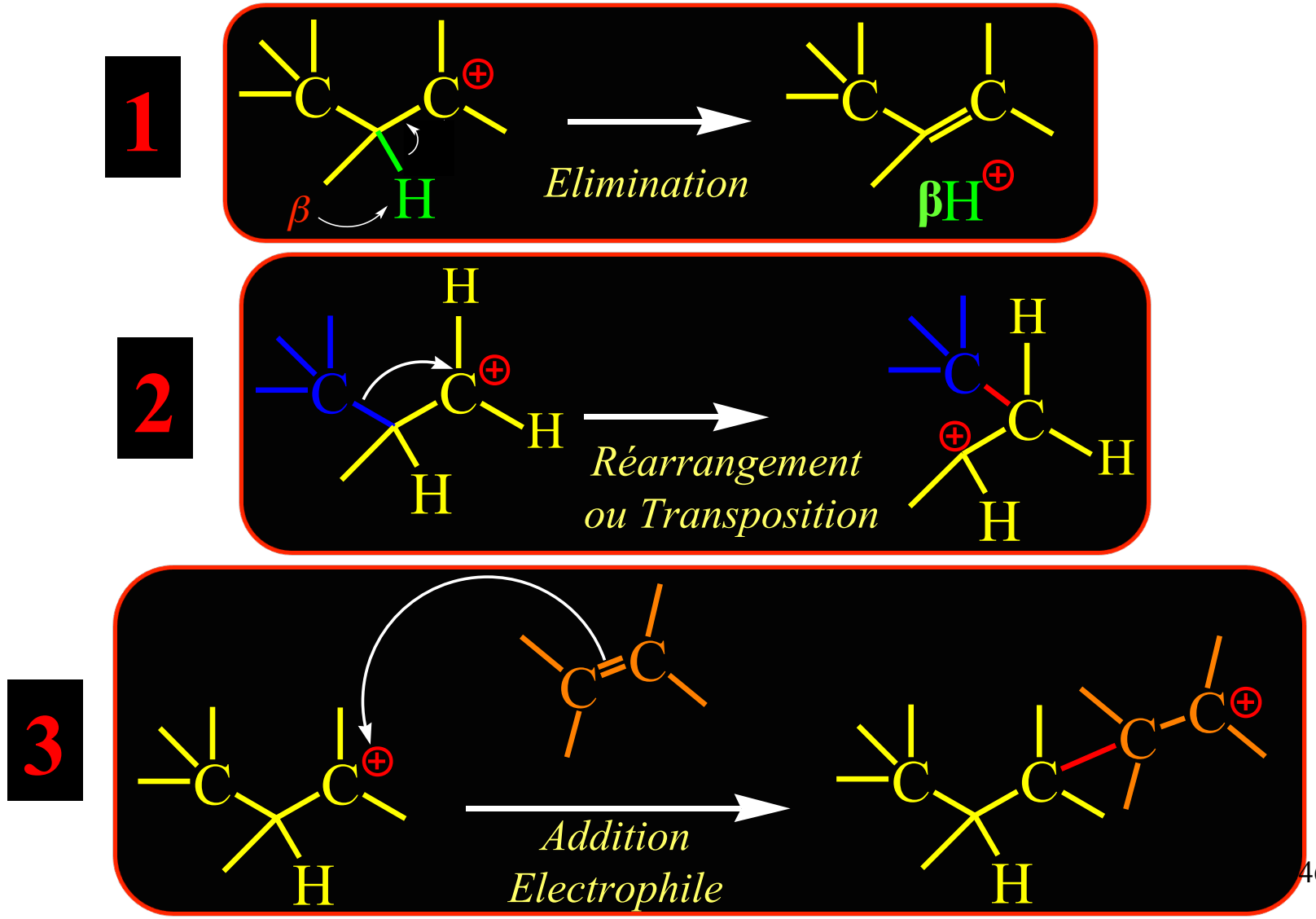


Carbocation II

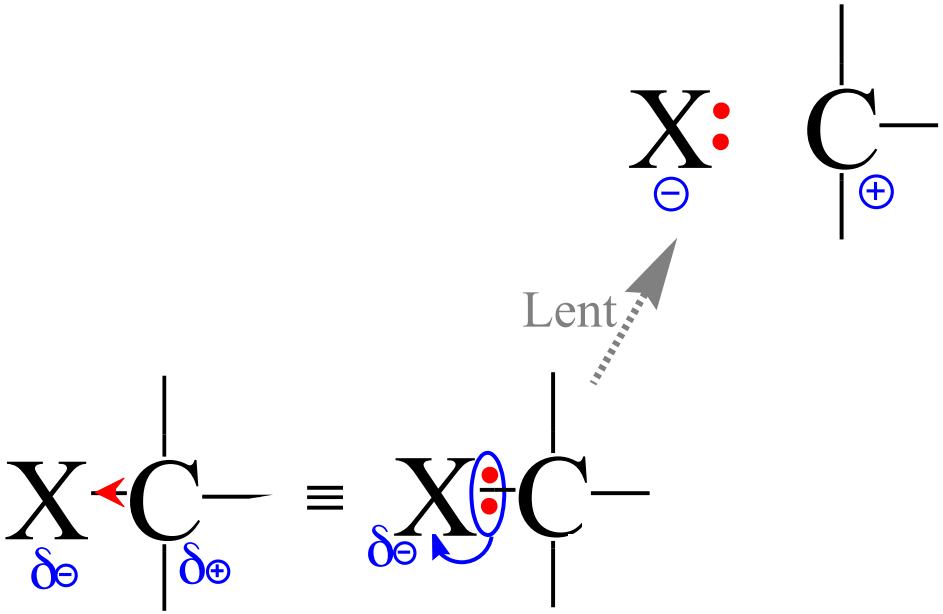
+ stable



Réactions Fondamentales des Carbocations



Réactions Fondamentales des Carbocations



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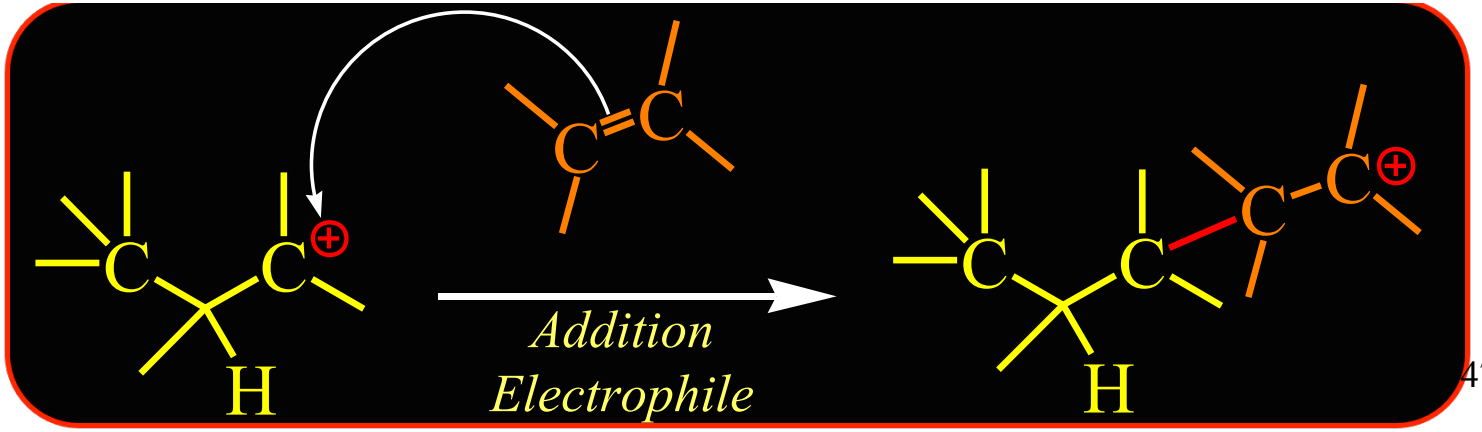
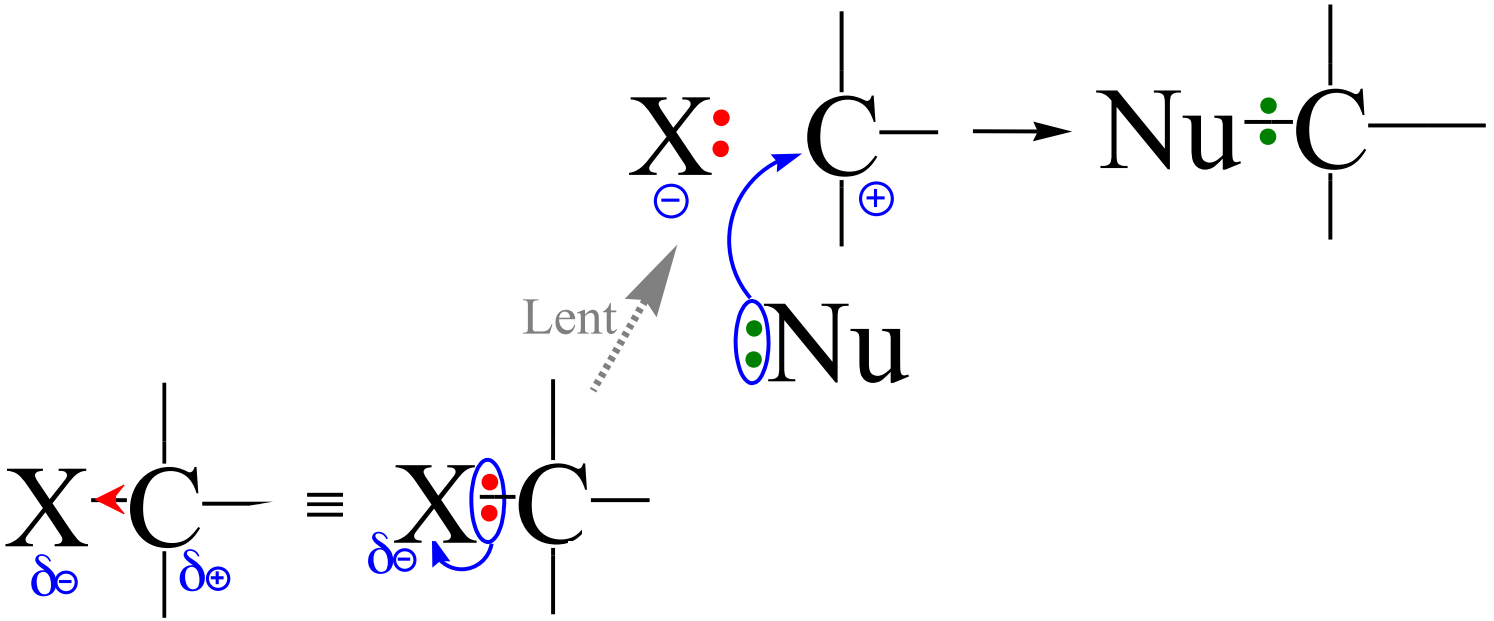


Réactions Fondamentales des Carbocations



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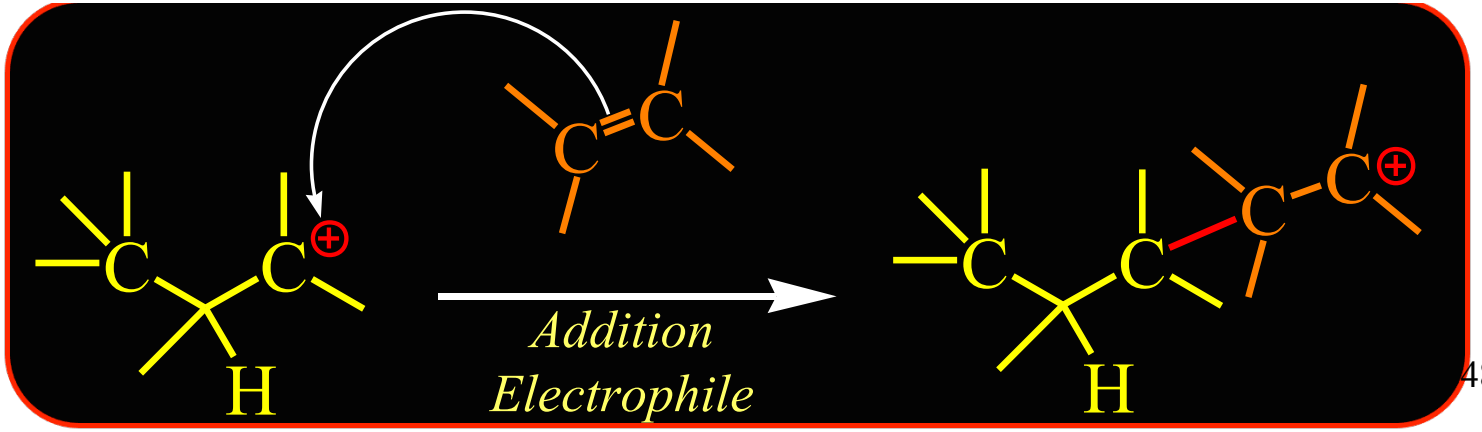
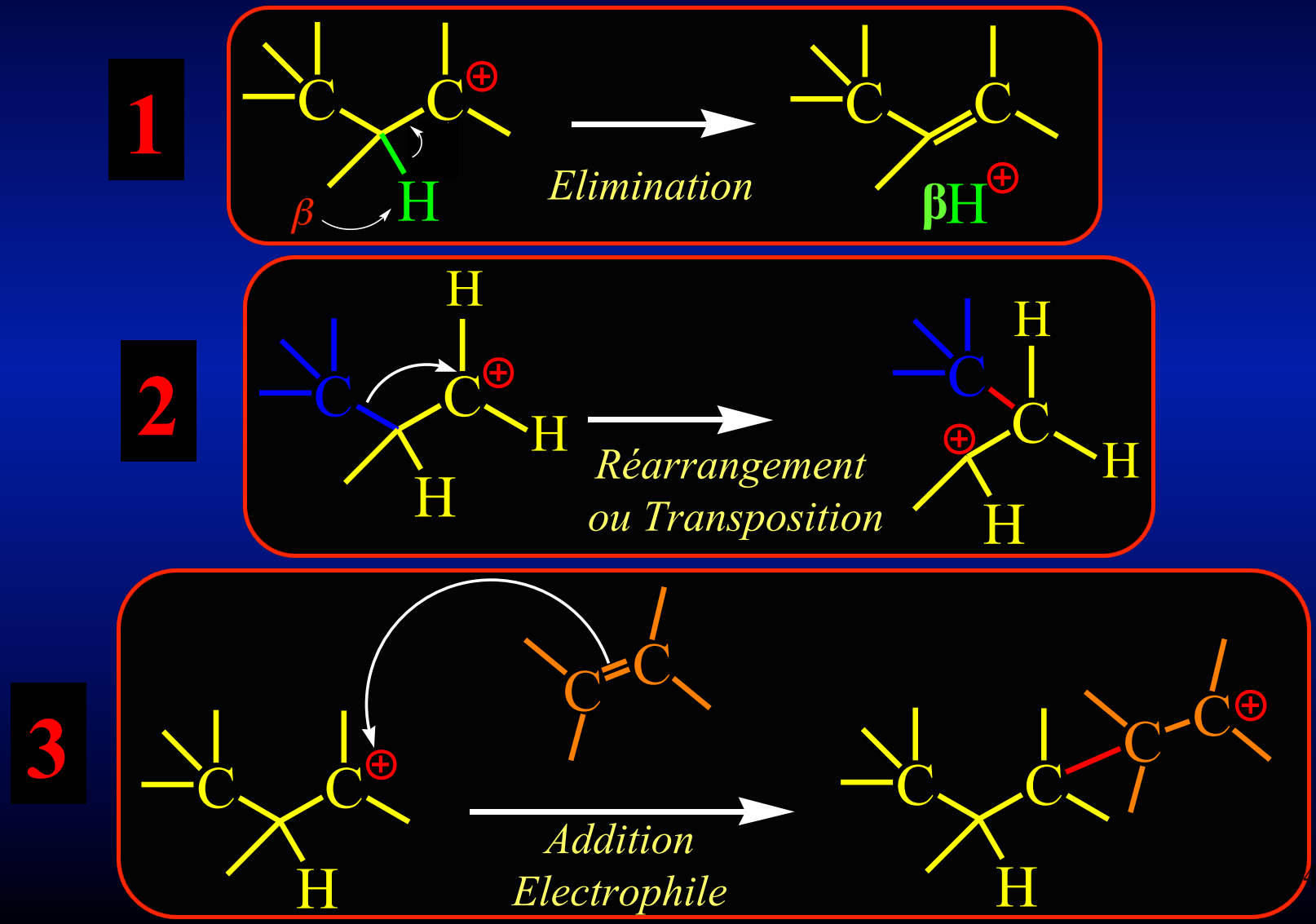
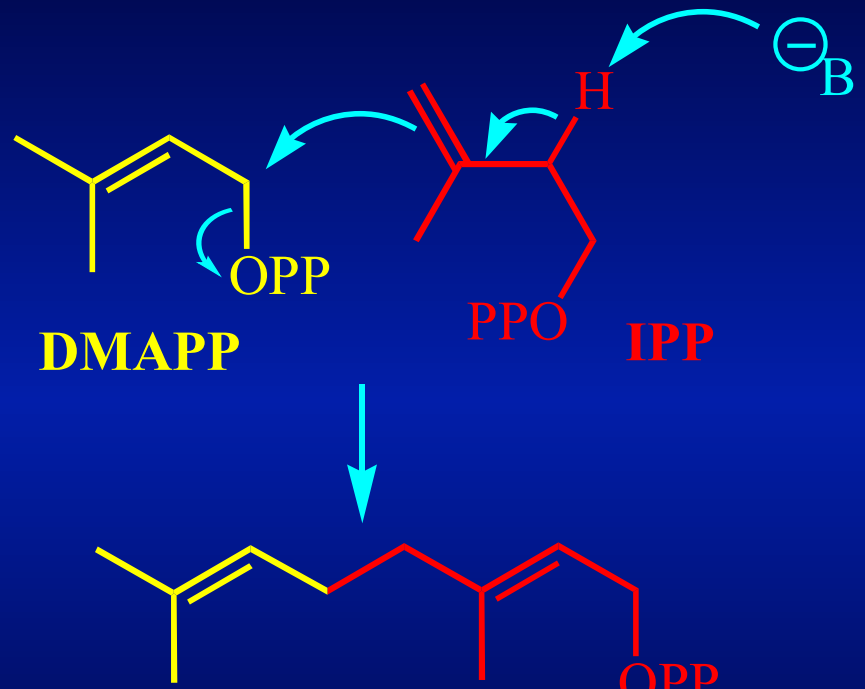


Réactions Fondamentales des Carbocations



La Biosynthèse des Monoterpénoïdes

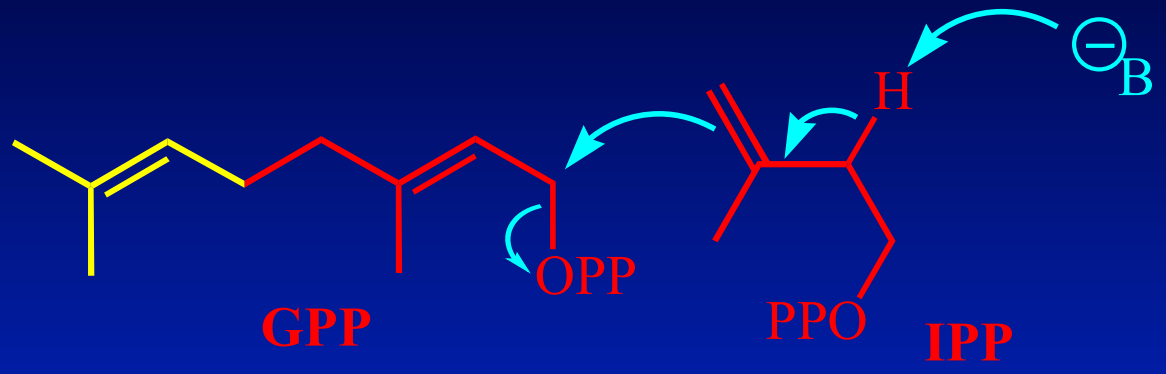


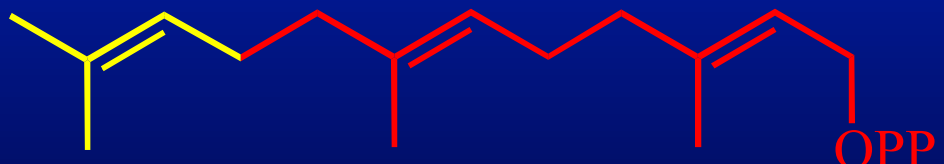
Géranyl pyrophosphate (**GPP**)

$(C_5H_8)_n$ / n = 2

MONOTERPENOIDES

La Biosynthèse des Sesquiterpénoïdes



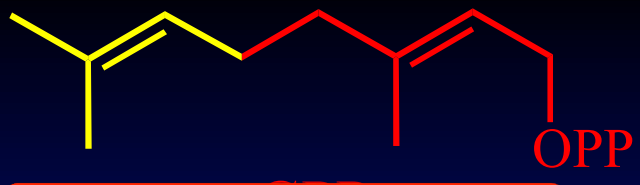


Farnésyl pyrophosphate (**FPP**)

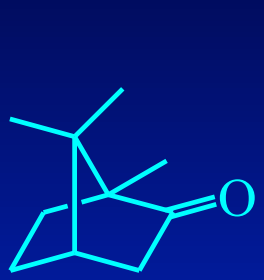
$(C_5H_8)_n$ / n = 3

SESQUITERPENOIDES

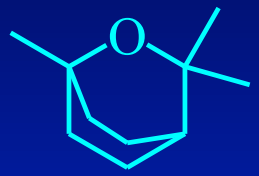
Monoterpénoïdes (C_{10})



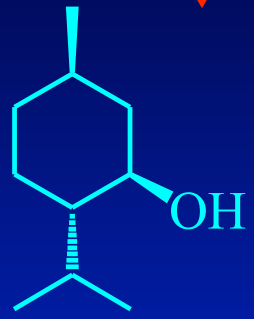
Géranyl pyrophosphate (**GPP**)



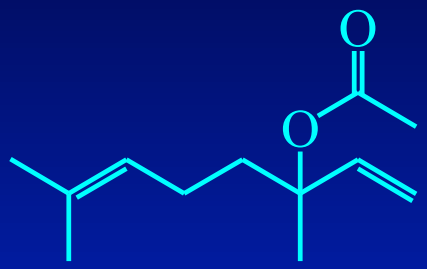
Camphre



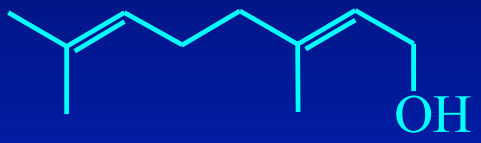
1,8-cinéole



Menthol

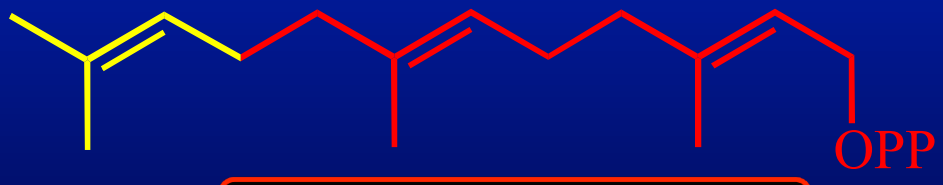


Acétate de linalyle

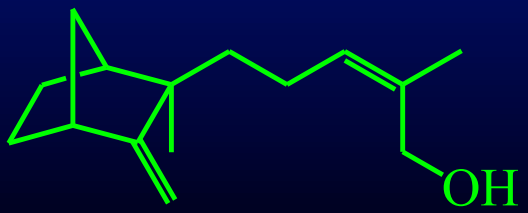


Géraniol

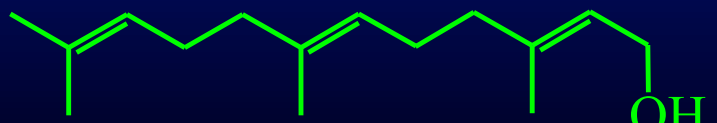
Sesquiterpénoïdes (C_{15})



Farnésyl pyrophosphate (**FPP**)

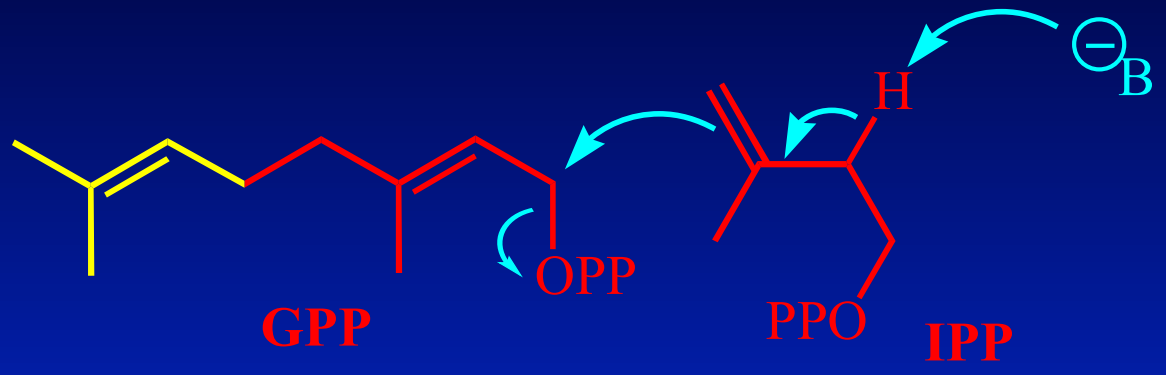


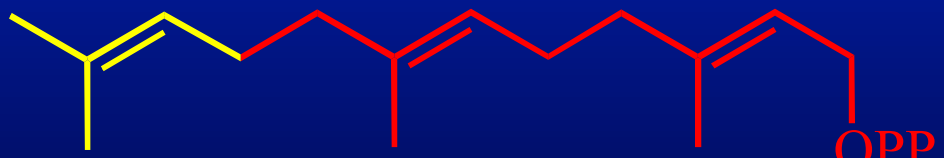
β-santalol



Farnésol

La Biosynthèse des Sesquiterpénoïdes



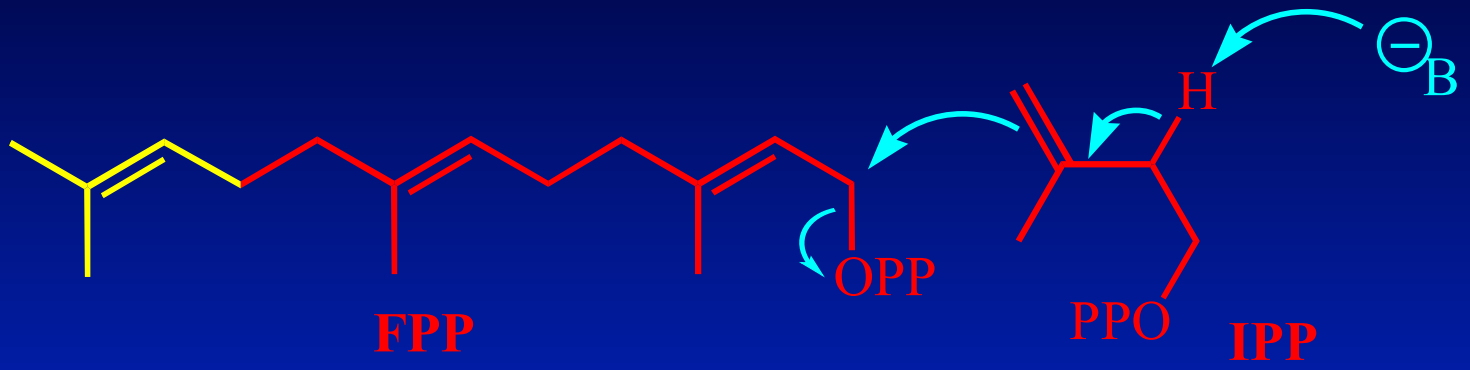


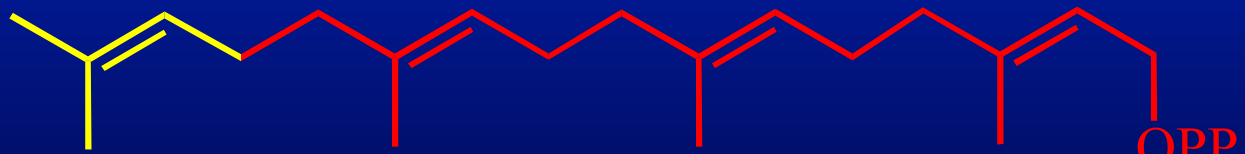
Farnésyl pyrophosphate (**FPP**)

$(C_5H_8)_n$ / n = 3

SESQUITERPENOIDES

La Biosynthèse des Diterpénoïdes



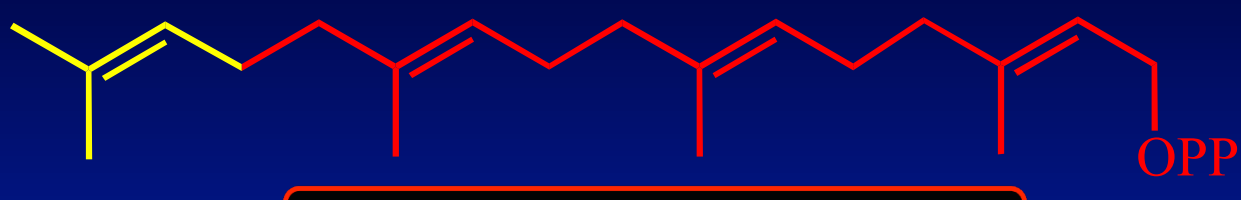


Géranylgéranyl pyrophosphate (G**GPP**)

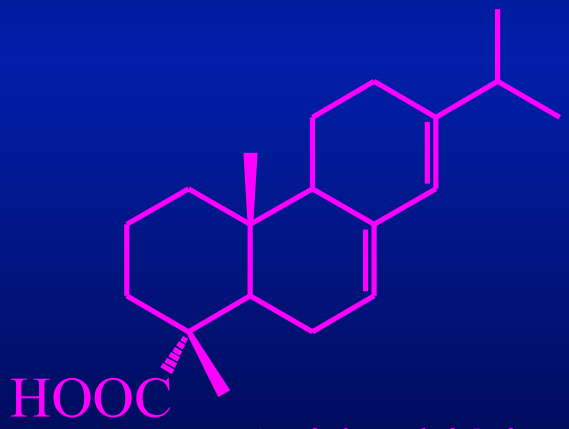
$(C_5H_8)_n$ / n = 4

DITERPENOIDES

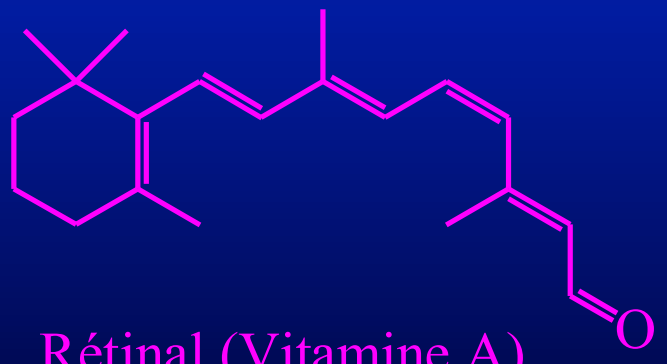
Diterpénoïdes (C_{20})



Géranylgéranyl pyrophosphate (G**GPP**)

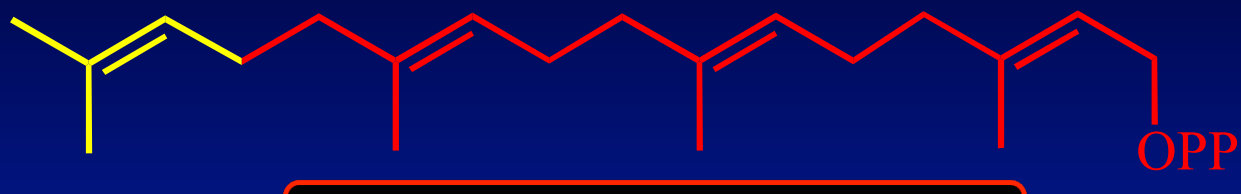


Acide abiétique

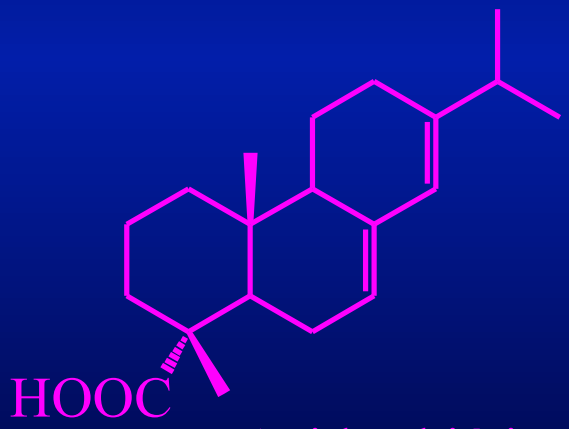


Rétinal (Vitamine A)

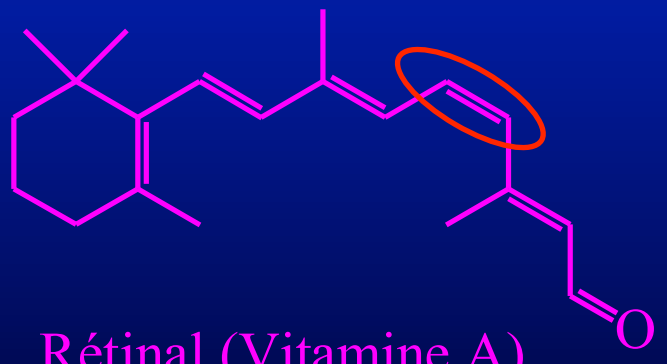
Diterpénoïdes (C_{20})



Géranylgéranyl pyrophosphate (G**GPP**)



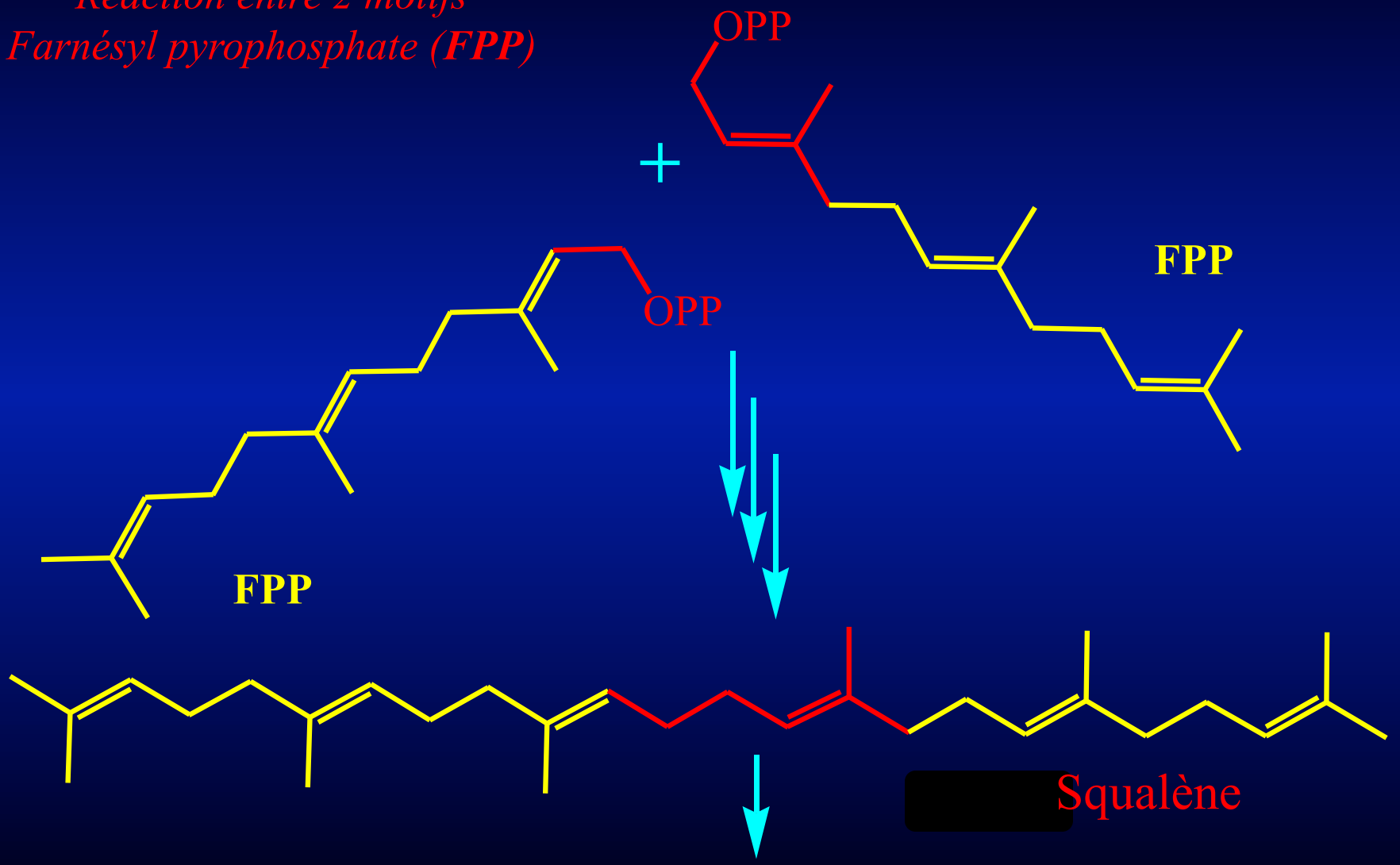
Acide abiétique



Rétinal (Vitamine A)

La Biosynthèse des Triterpénoïdes

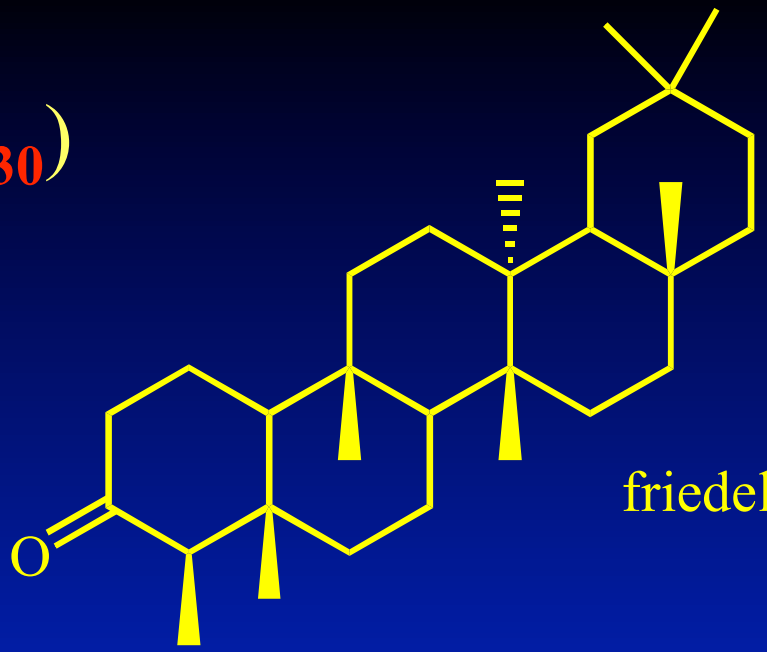
Réaction entre 2 motifs
*Farnésyl pyrophosphate (**FPP**)*



$(C_5H_8)_n$ / n = 6

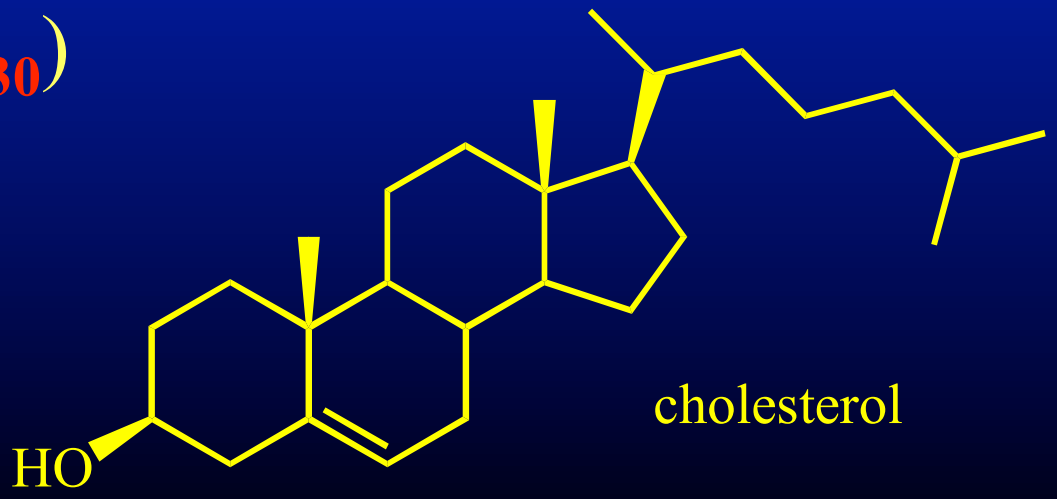
TRITERPENOIDES

Triterpénoïdes (C_{30})



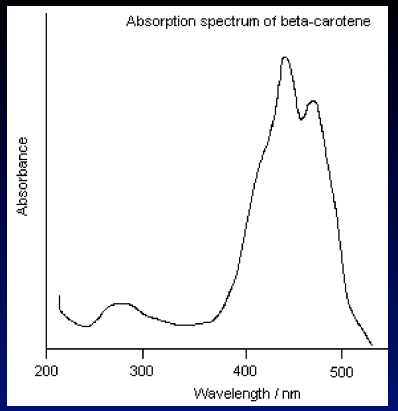
friedeline

Stéroïdes ($< C_{30}$)

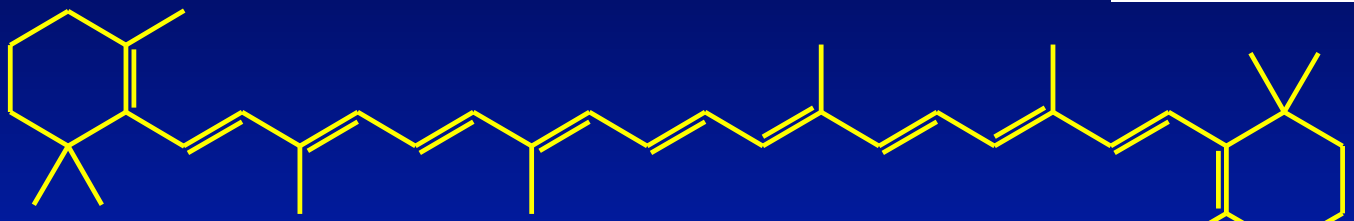


cholesterol

Les Terpénoïdes

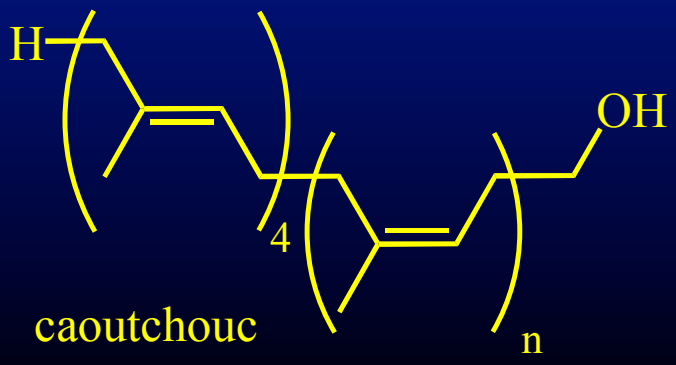


Caroténoïdes (C_{40})



β-carotène

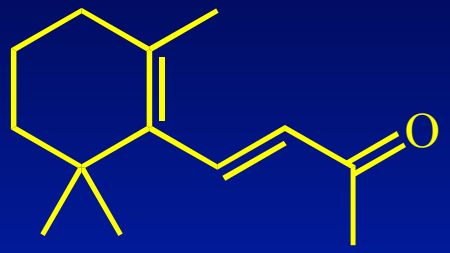
Polyisoprénoïdes (C_{45}- C_{500000})



caoutchouc

Les produits dérivés des terpénoïdes

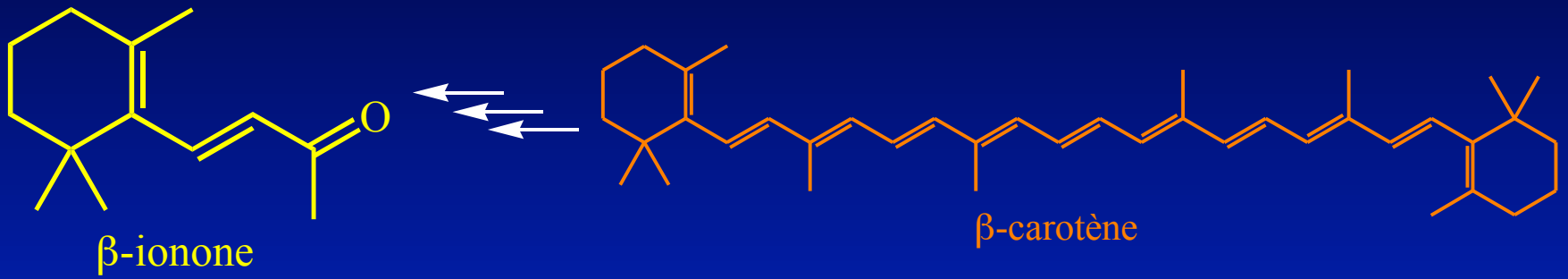
Norterpénoïdes :



β-ionone

Les produits dérivés des terpénoïdes

Norterpénoïdes :

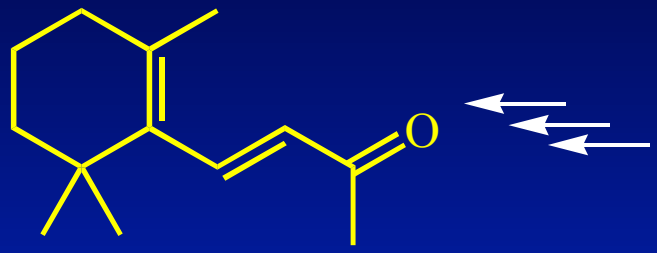


β-ionone

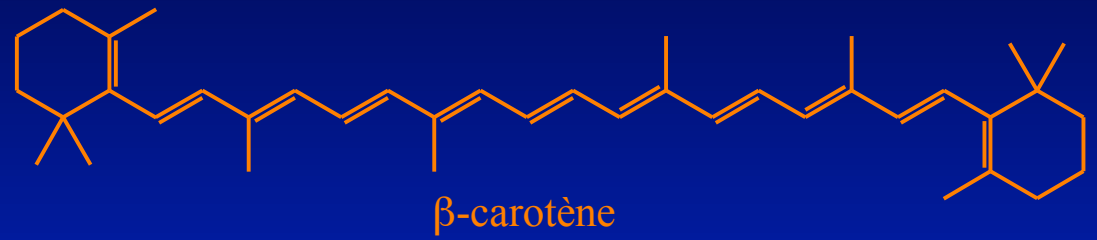
β-carotène

Les produits dérivés des terpénoïdes

Norterpénoïdes :

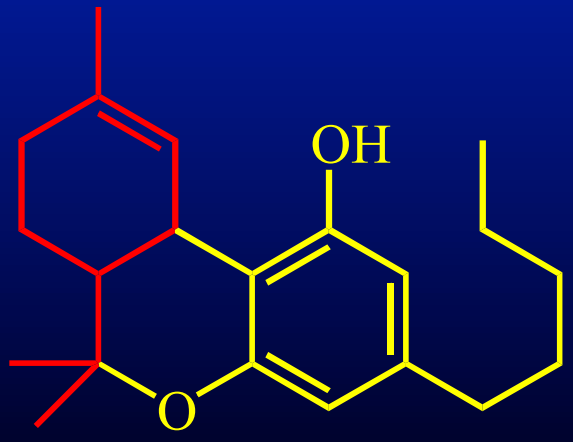


β-ionone

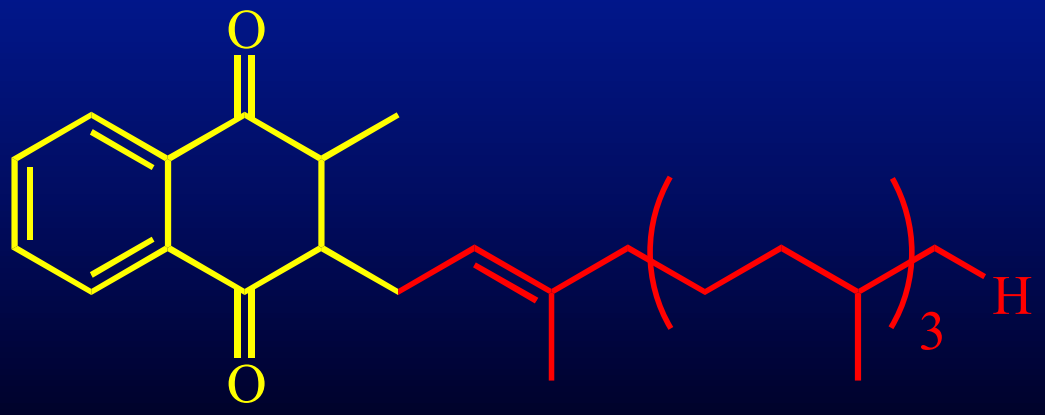


β-carotène

Méroterpénoïdes :



THC



Vitamine K1

Les Rôles des Terpénoïdes

Chez les plantes :

* pigments
* insecticides ou répulsifs
* attraction des insectes
* hormone de croissance

Chez les insectes :

* phéromones (sexuelles, de chemin, d'alarme)
* sécrétions défensives

Les matières premières de la parfumerie

Huile essentielle : obtenue par hydrodistillation

Teinture : Produit de macération dans l'alcool

Concrète : Extrait au solvant hydrocarbure (ex : hexane)

Absolue : Portion de la concrète soluble dans l'alcool

L’apport de la chimie

L’apport de la chimie

Les nouvelles techniques d’extraction

L'apport de la chimie

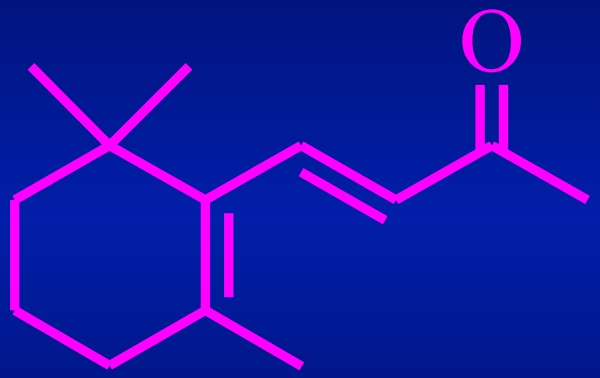
Fougère royale
(Paul Parquet, Houbigant, 1882)

Mousse de chêne,
géranium, bergamote,
coumarine

L’apport de la chimie

L’arrivage de la violette

L’apport de la chimie

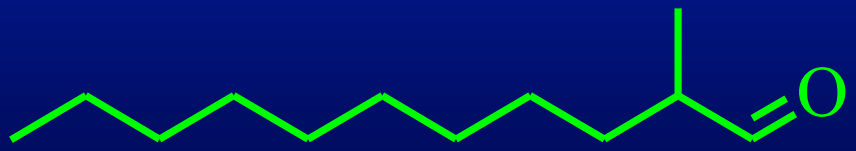


β-ionone (1893)

La note violette

L’apport de la chimie

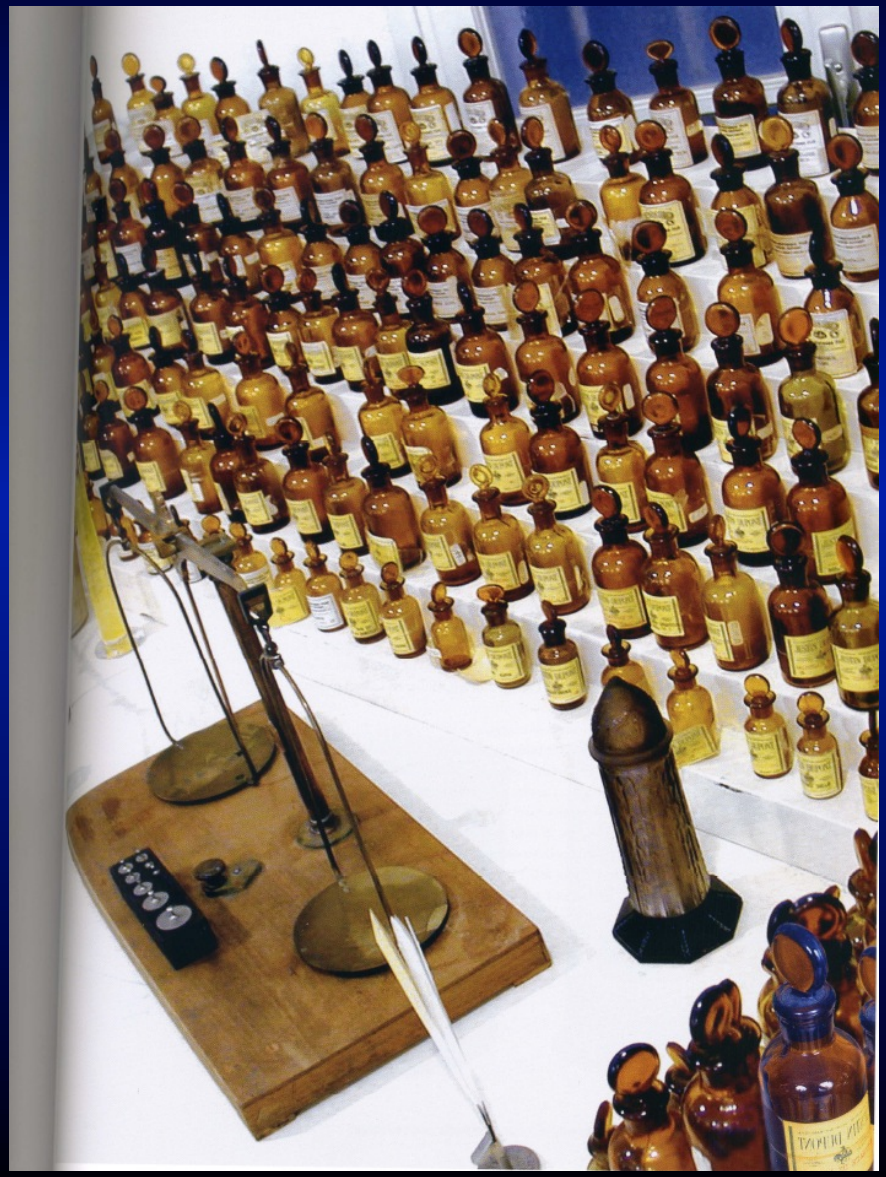
Chanel n°5
(Ernest Beaux, 1921)



2-méthylundécanal

Le travail des parfumeurs

Le travail des parfumeurs



Le vocabulaire des parfumeurs

Musical et pictural : notes, touches, cuivres, contrastes, rythmes lents/vifs…

Architectural : base, charpente, solidité…

Météorologique : chaud, froid…

Culinaire : sucré, poivré, pétillant, épicé, acidulé, brûlé…

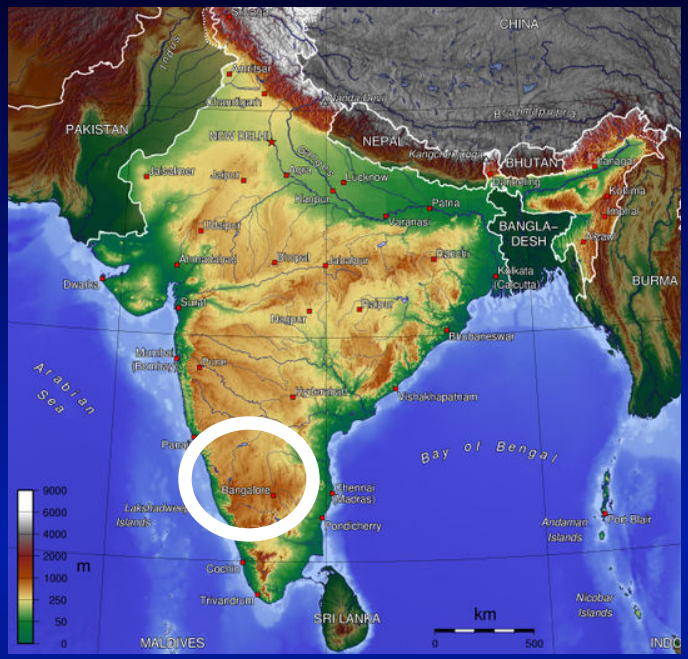
Etc…

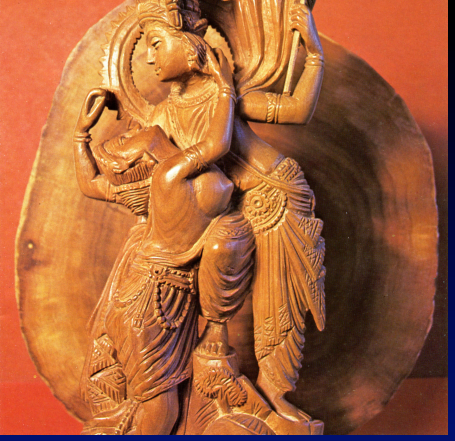
Le vocabulaire des parfumeurs

« Je sais le comportement, le caractère de chacun ; il y a les espiègles comme la mandarine, les sages comme le santal, les doux comme la vanilline, les violents comme les aldéhydes, parfois des imprévisibles comme le buchu. Ils ont tous une fâcheuse habitude, c'est de vouloir s'unir, et éternellement de la même façon : l'oranger avec l'iris, l'iris avec la rose, la rose avec le patchouli… »

Jean-Claude Ellena.

Le bois de Santal *Santalum album* (L.)



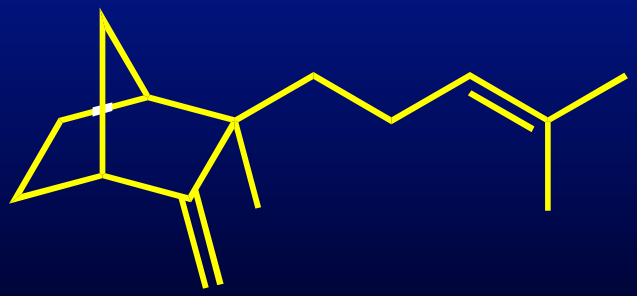


La note santal

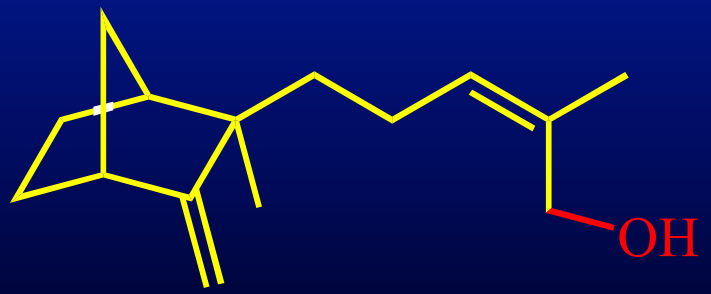
“Caractéristique, persistant, inimitable, multifacette, doux, **boisé**, animal, sueur, urine, lacté, noix, très bon fixateur…”

Le bois de santal

Santalum album



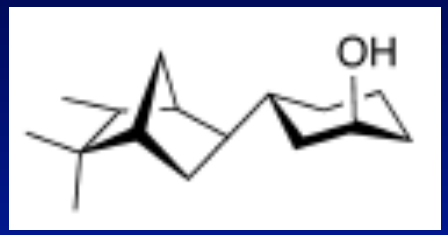
β-santalène



β-santalol

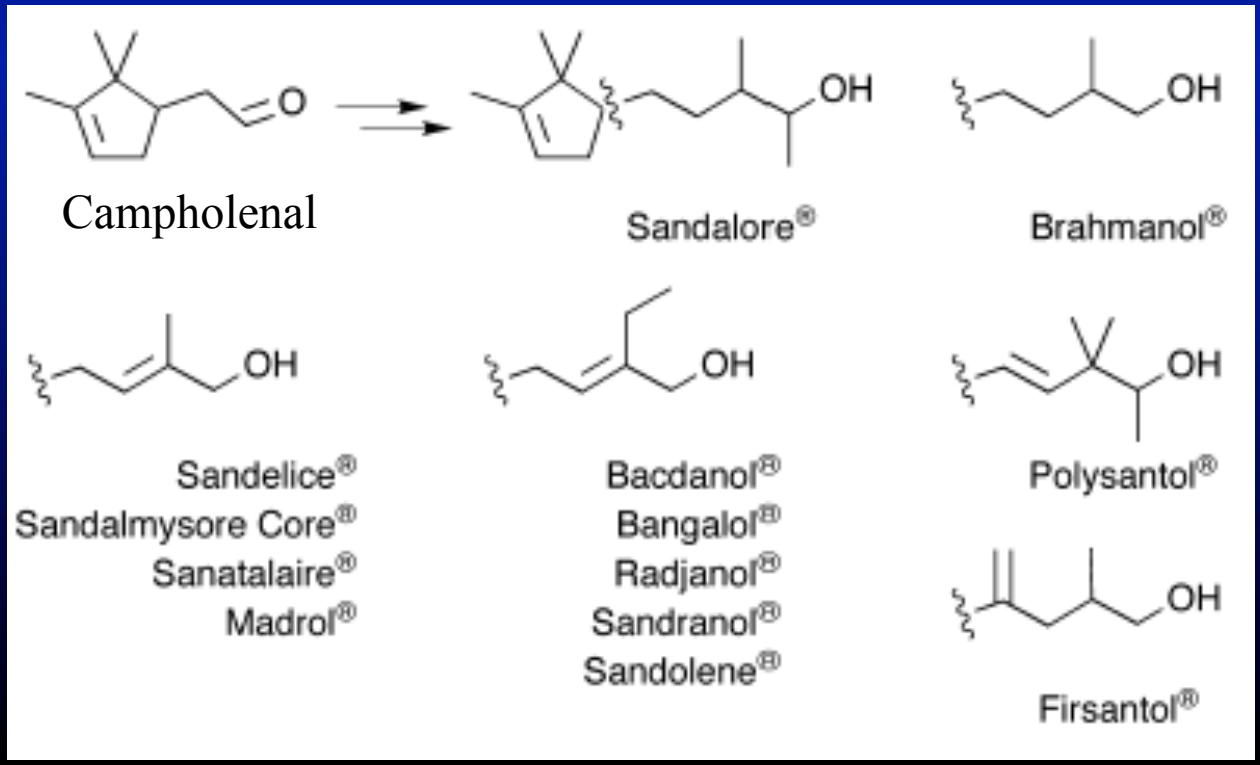
Les composés à odeur de bois de santal

1ère génération :



β-santalol

Derives du campholenal :



Le patchouli *Pogostemon cablin*

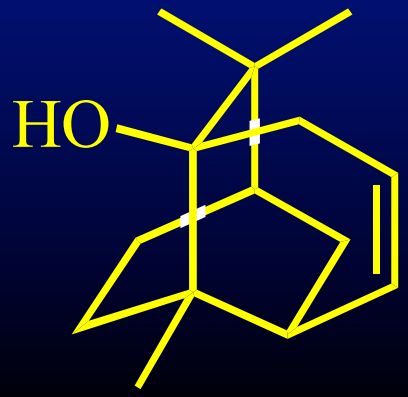
Janis JOPLIN

Le patchouli

Pogostemon cablin

patchoulol

norpatchoulenol (0.35-1%)



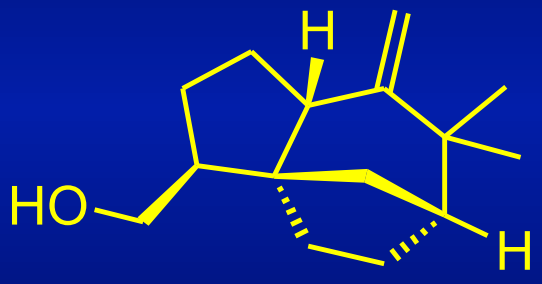
Le Vétiver *Vetiveria zizanioides* (L.) Nash

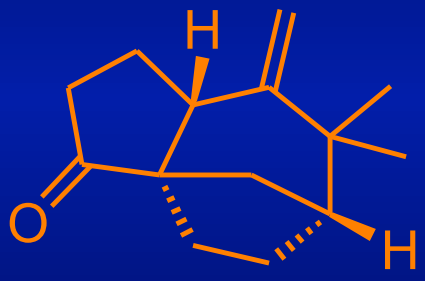
La note vétiver

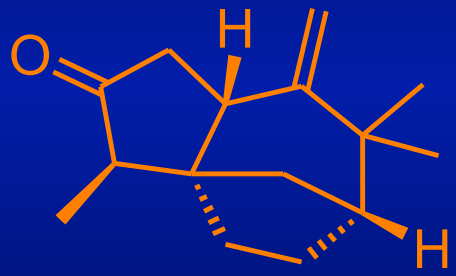
“Doux, lourd, boisé, terreux, sol mouillé, pamplemousse…”

Le vetiver

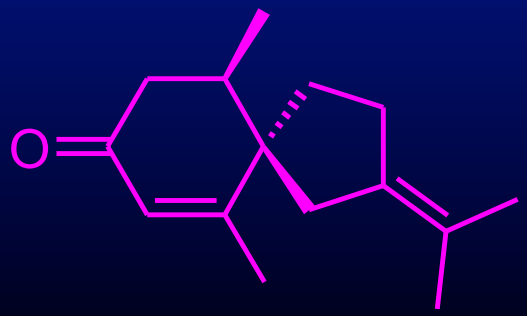
Constituants de
l'huile essentielle :

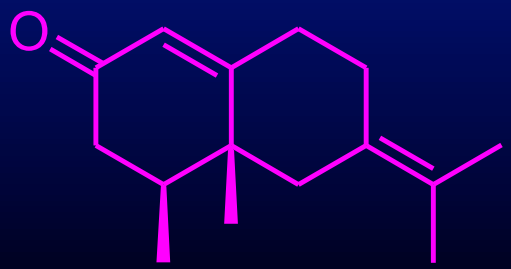




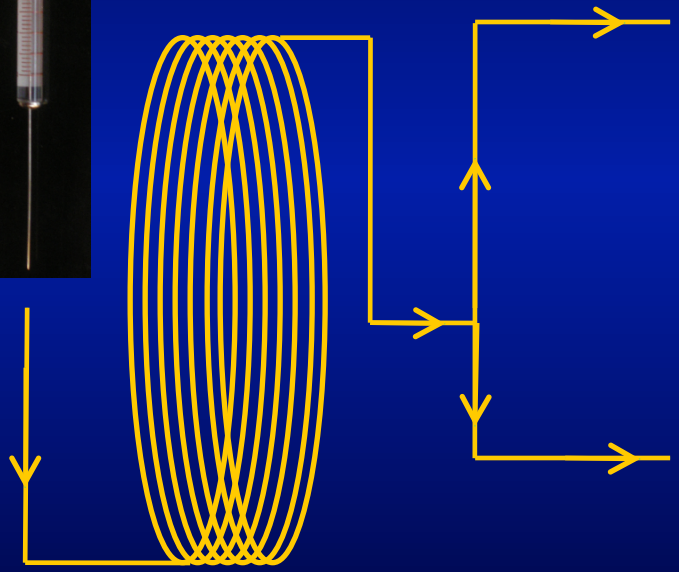


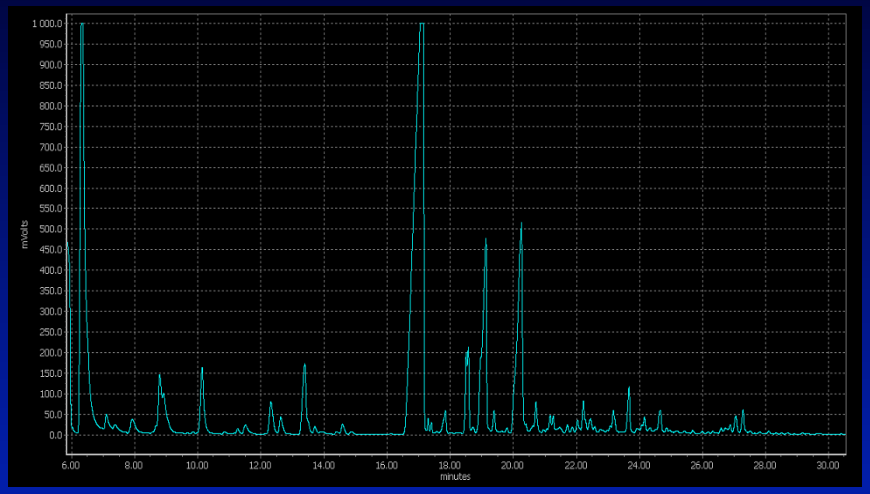
(encore peu explorées)



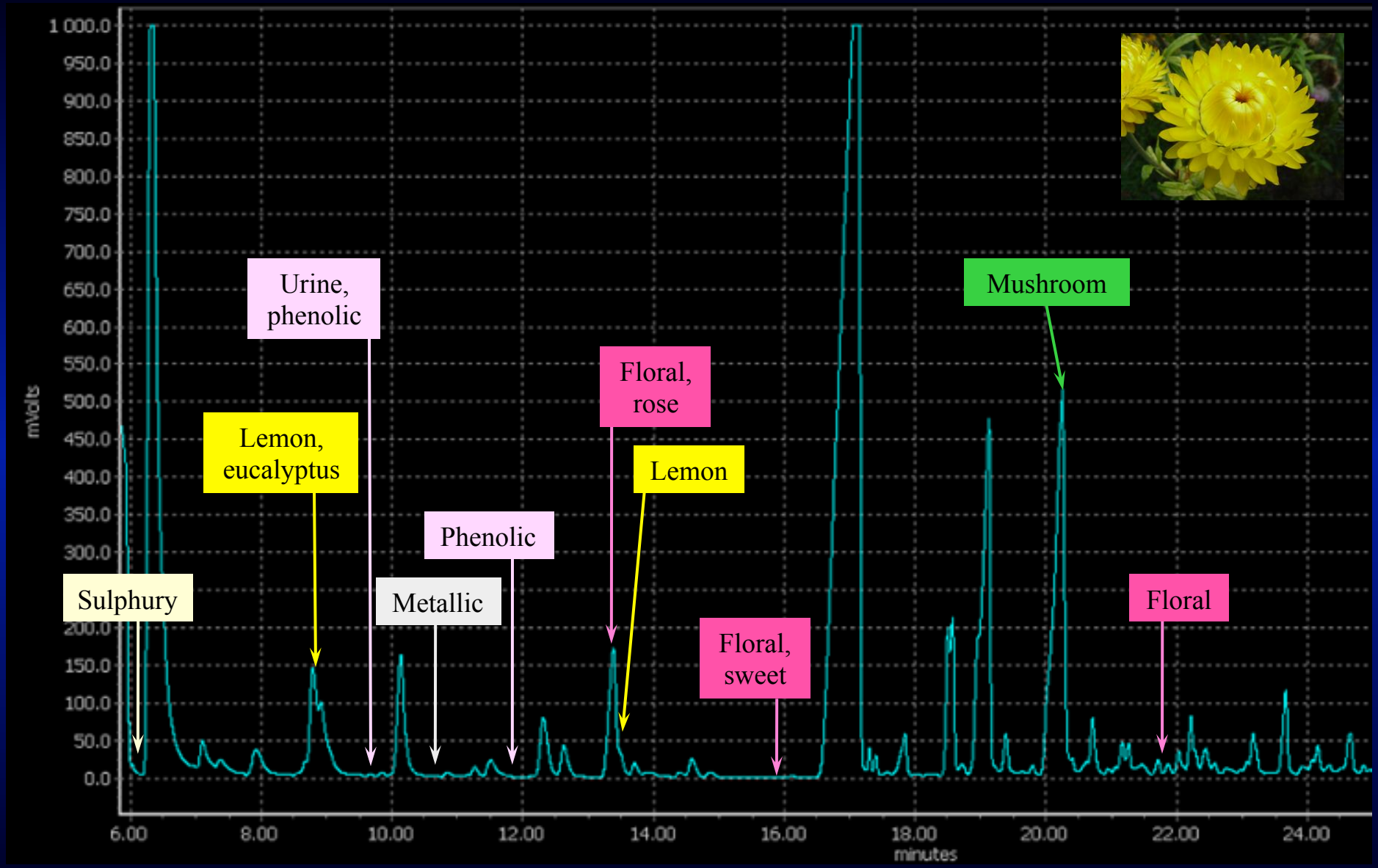


Gas Chromatography - Olfactometry





L’immortelle d’Italie



Le musc

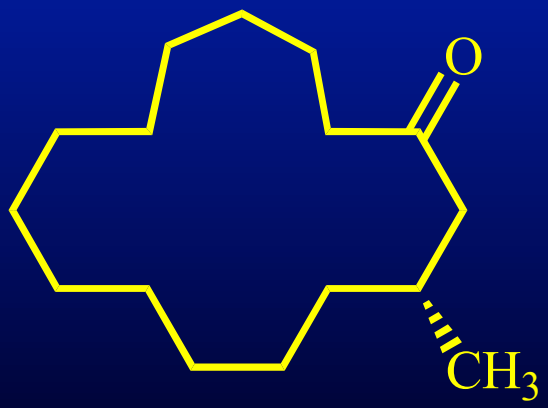
Moschus moschiferus

Le musc

Moschus moschiferus

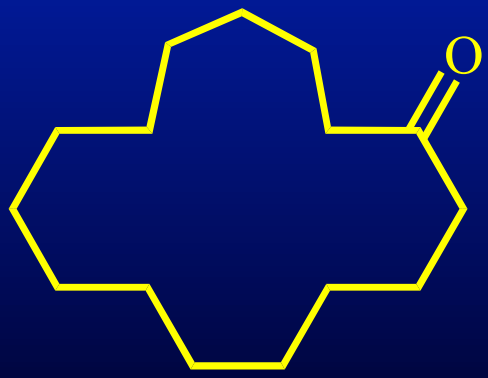
1906 : Walbaum isole le principal composant odorant du musc : $C_{16}H_{30}O$ (muscone).

1926 : Ruzicka en détermine la structure, ainsi que celle de la civettone (Grande avancée en chimie organique académique, Prix Nobel en 1939).



Muscone

Civettone

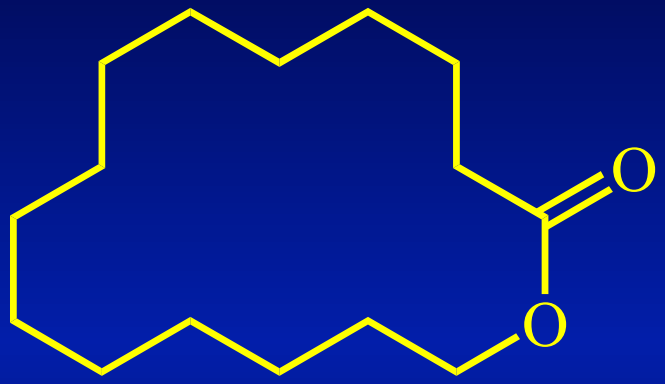


Exaltone

Les muscs végétaux

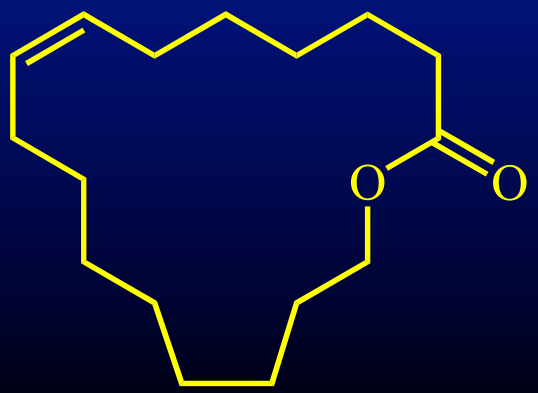
Archangelica officinalis :

Exaltolide

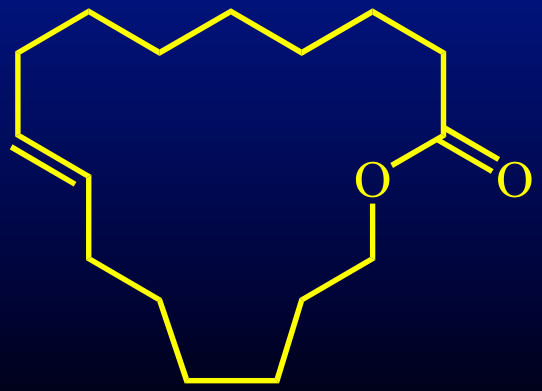


Prod. (1996) : 200 t/an

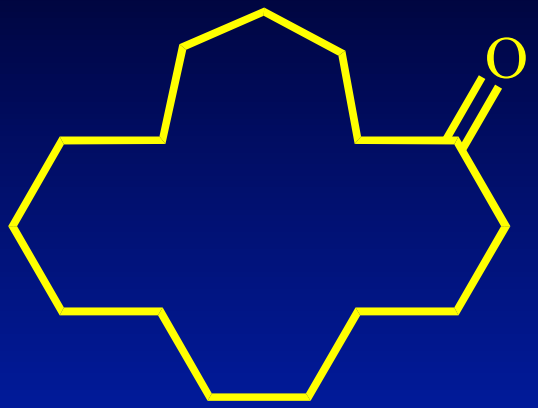
Hibiscus abelmoschus :



Ambrettolide®

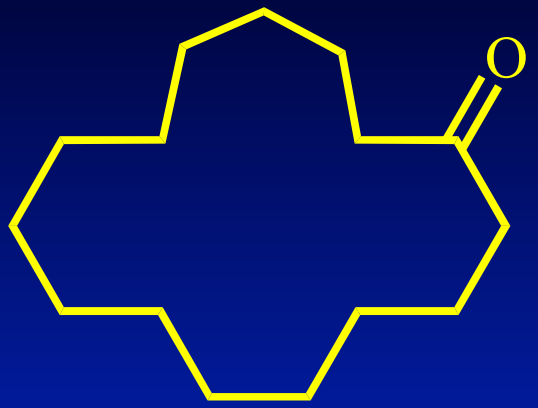


Les muscs de synthèse



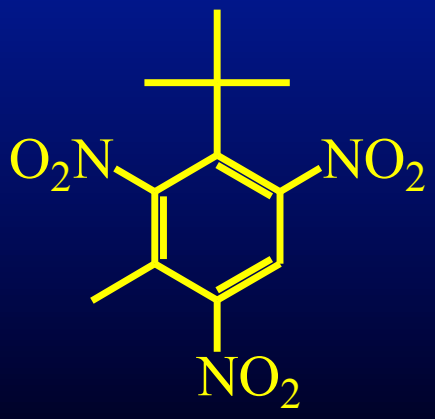
Exaltone

Les muscs de synthèse



Exaltone

Albert Baur (1888)

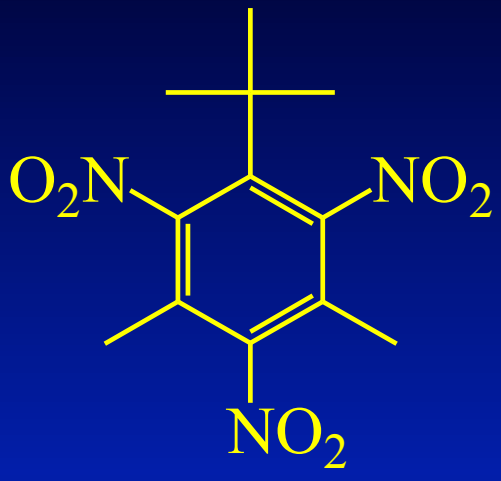


Musc Baur

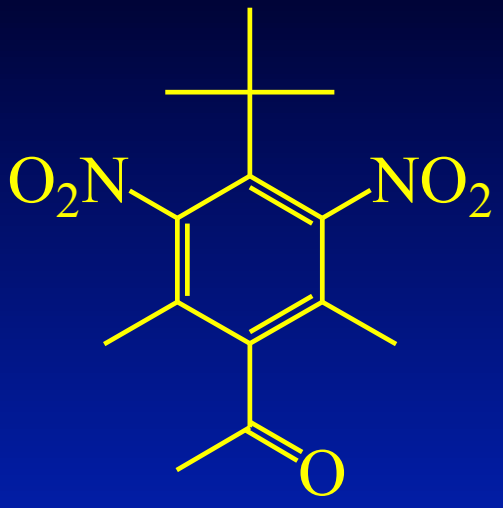
TNT

Les muscs de synthèse

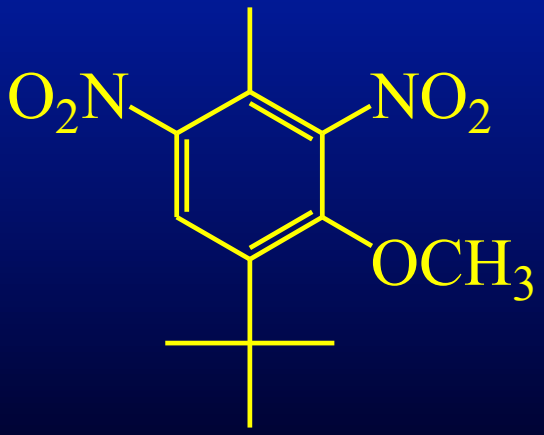
Musc Baur



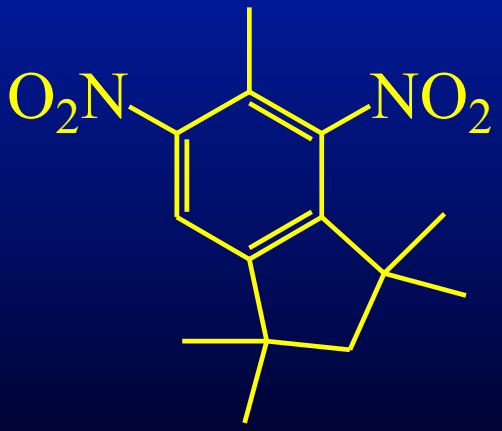
Musc Xylène



Musc Cétone

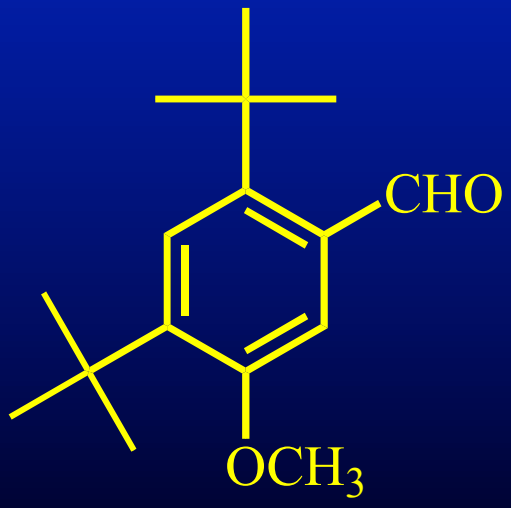


Musc Ambrette

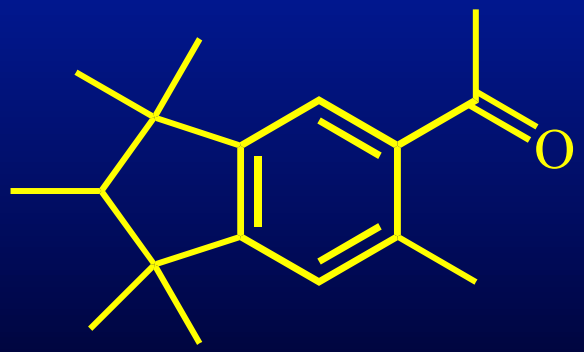


Moskène

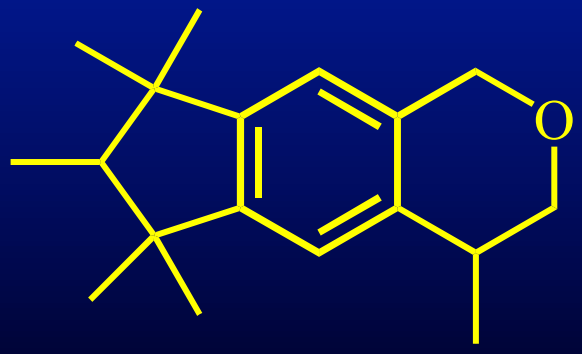
Vers les muscs polycycliques (PCM)



Ambral



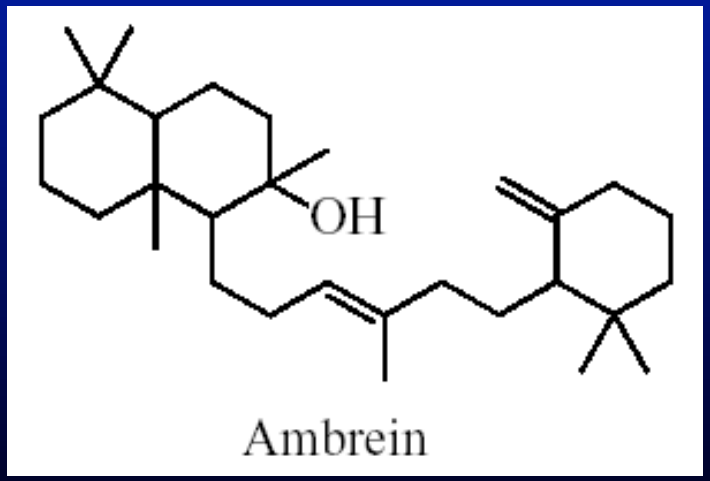
Phantolide



Galaxolide

L’ambre gris

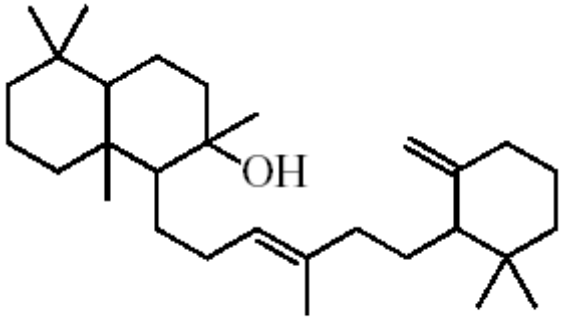
Physeter macrocephalus L.



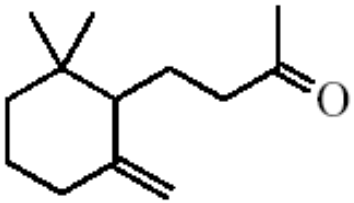
Ambrein

L'ambre gris

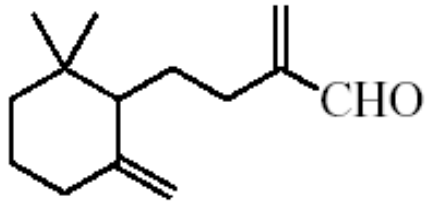
Physeter macrocephalus L.



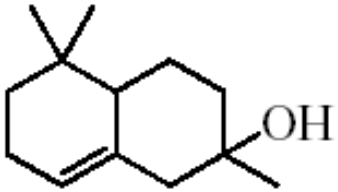
Ambrein



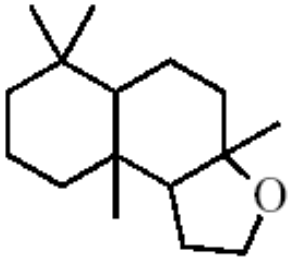
γ-Dihydroionone
(odor: tobacco)



(odor: seawater)

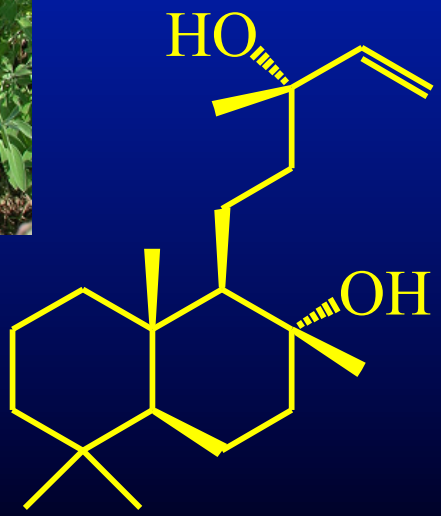


α-Ambrinol
(odor: moldy, animal, fecal)

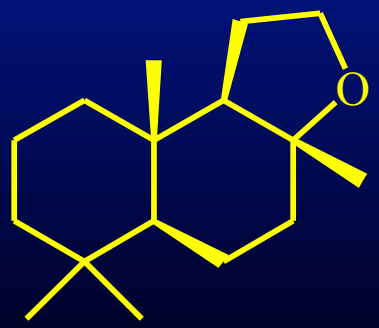


(odor: ambergris)

L’ambre gris – la sauge sclarée…



sclaréol



ambrox

L'if
(*Taxus brevifolia* Nutt.)

1960 : Campagne de recherche d'anticancéreux (NCI)

L'if
(*Taxus brevifolia* Nutt.)

1960 : Campagne de recherche d'anticancéreux (NCI)

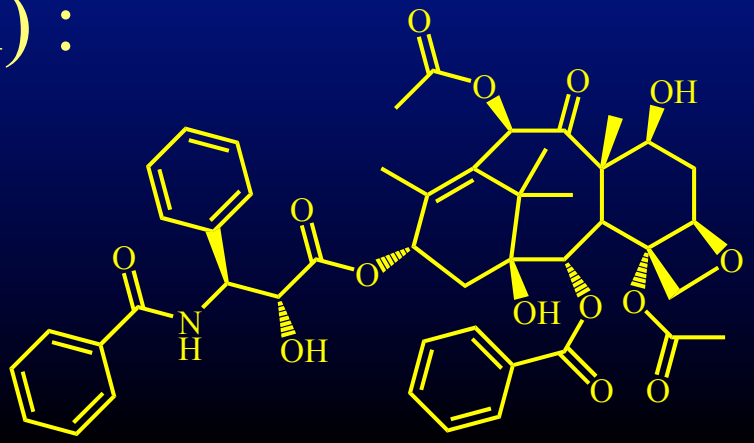
1964 : Wall & Wani montrent l'activité d'extraits de *Taxus brevifolia* Nutt.

L'if
(*Taxus brevifolia* Nutt.)

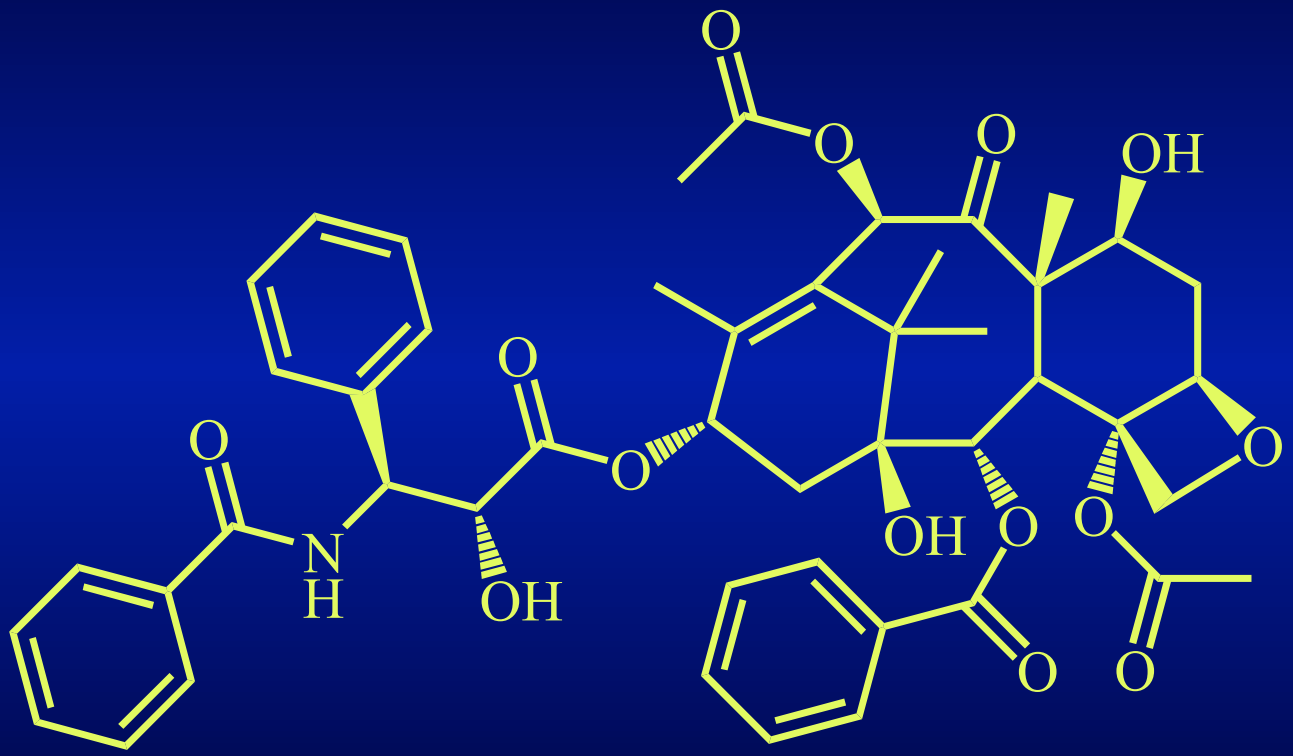
1960 : Campagne de recherche d'anticancéreux (NCI)

1964 : Wall & Wani montrent l'activité d'extraits de *Taxus brevifolia* Nutt.

1971 : Isolement et détermination de la structure du Taxol® (Paclitaxel) :



L'if
(*Taxus brevifolia* Nutt.)



Taxol® (Paclitaxel)

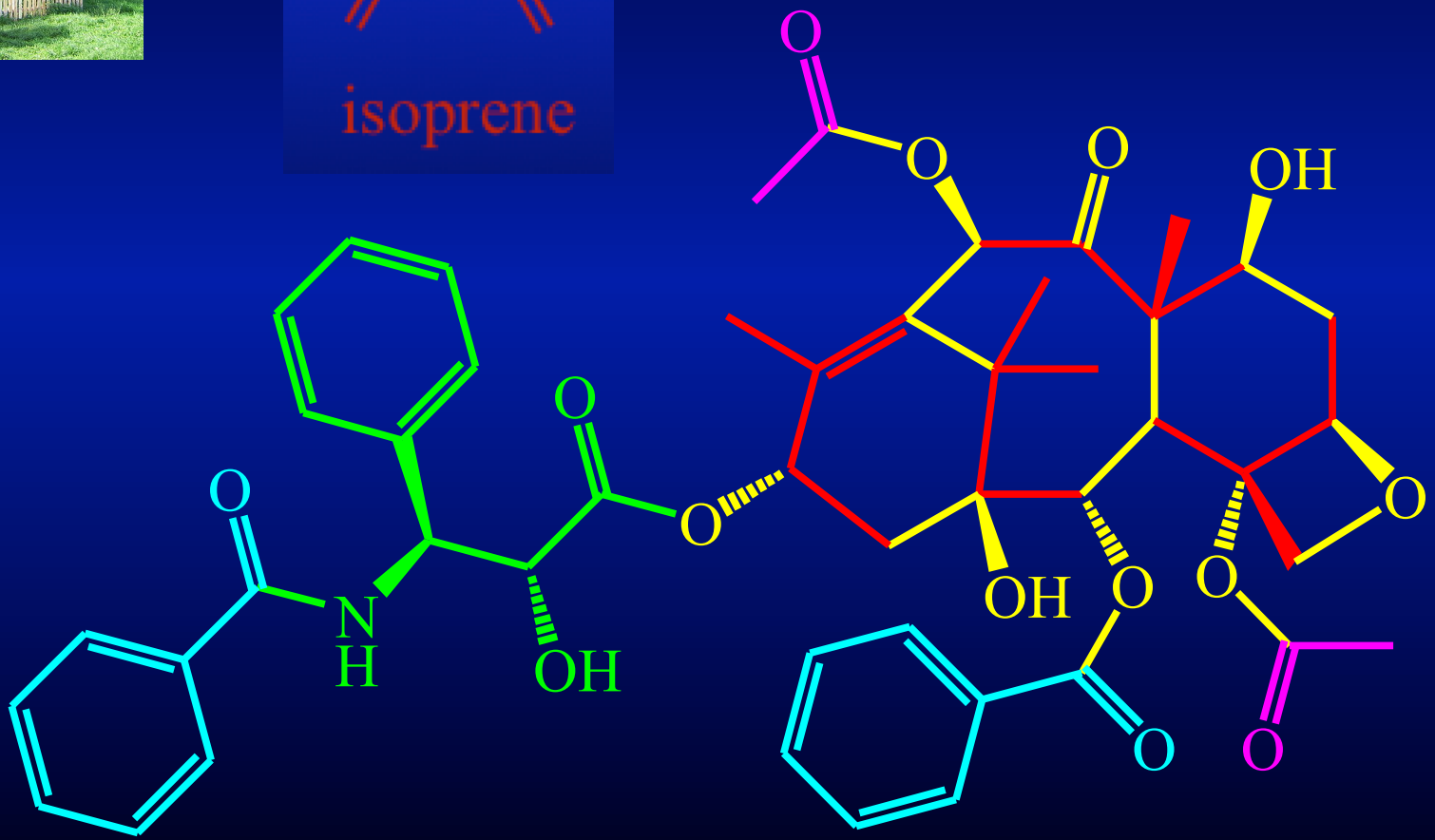
1g / 10 kg écorces

Biosynthèse du Taxol

Biosynthèse du Taxol

Biosynthèse du Taxol

Biosynthèse du Taxol



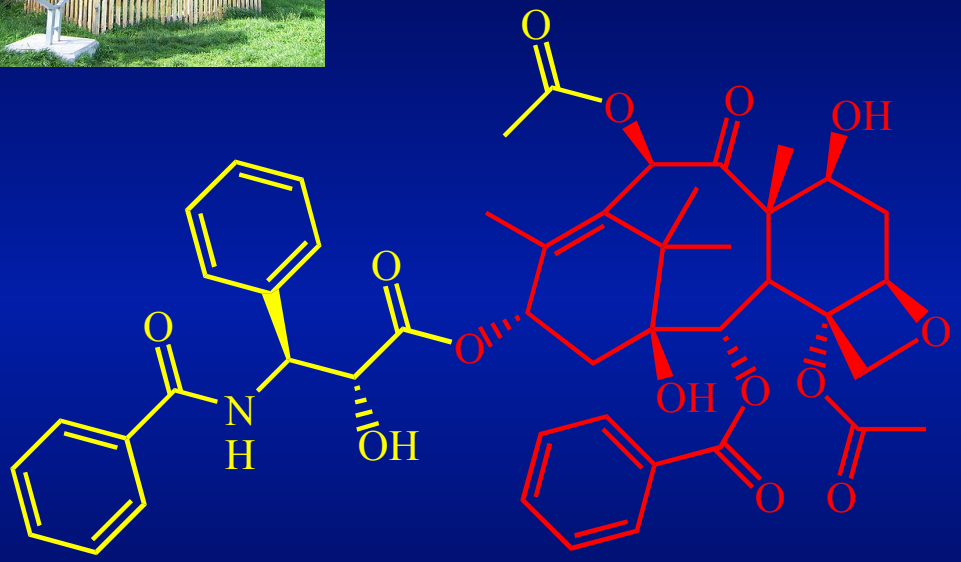
Taxus brevifolia Nutt.

Taxus baccata L.

Pierre Potier
(1934-2006)

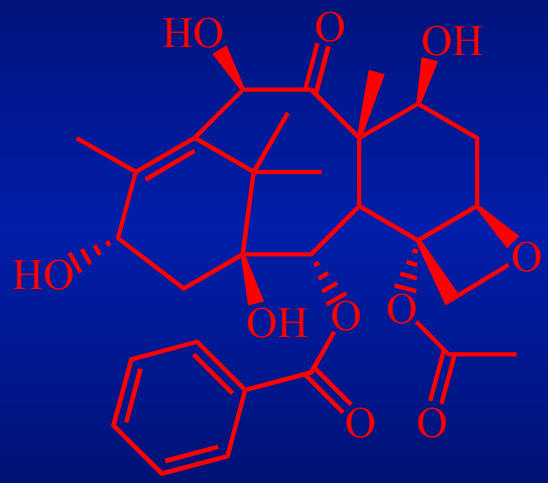
L'if

Taxus baccata L.



Taxol

1g / 10 kg écorces

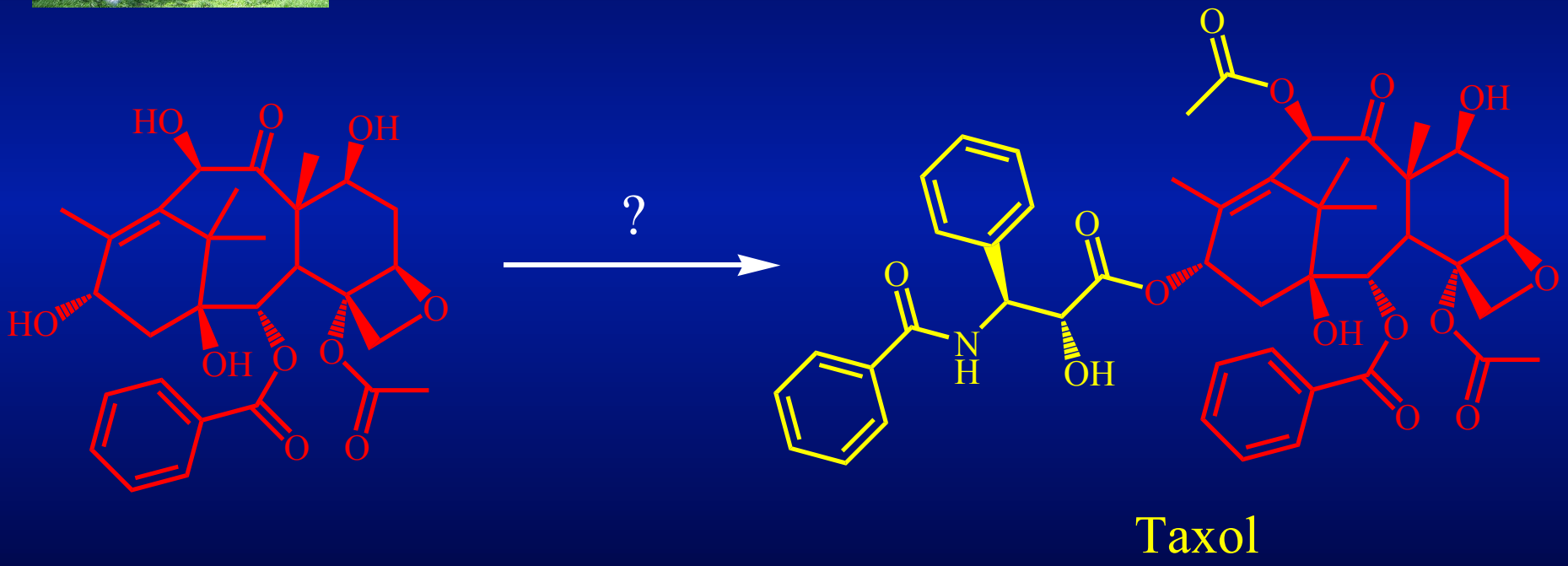


10-desacetylbaccatine III

1g / kg feuilles

L’if

Taxus baccata L.



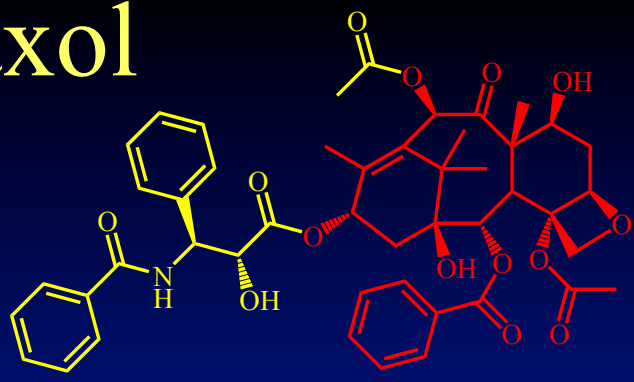
Taxol

L'if

Taxus baccata L.

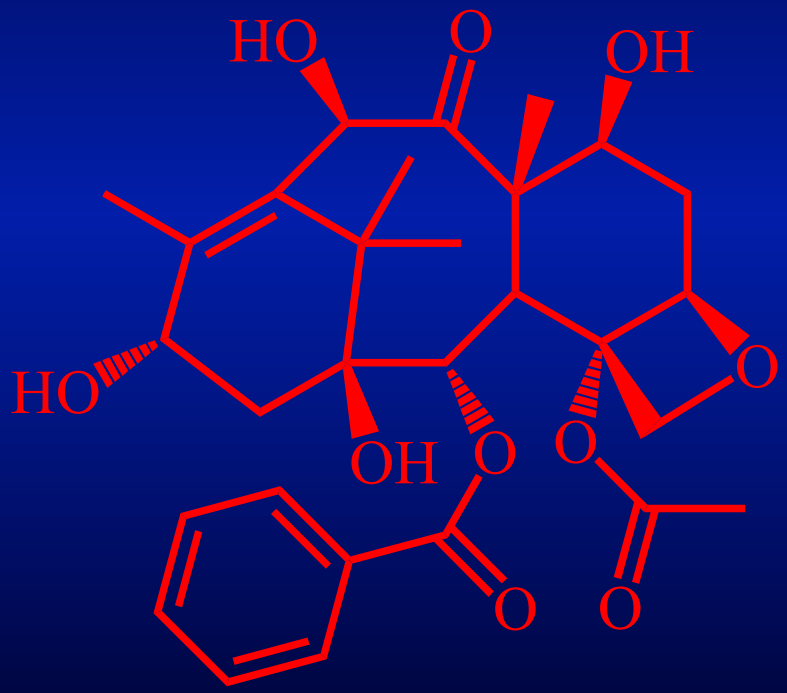
Taxol

Hémisynthèse du Taxol



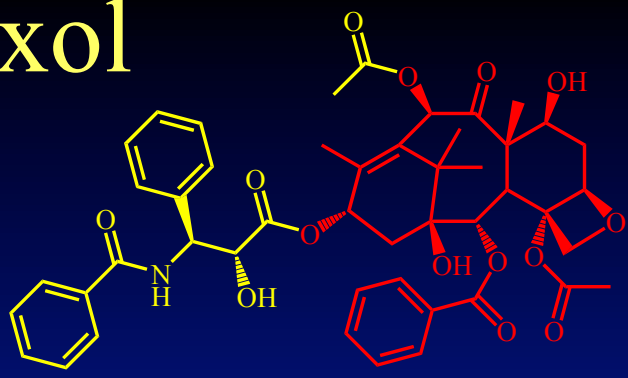
Taxol

Hydroxyle le moins réactif ?



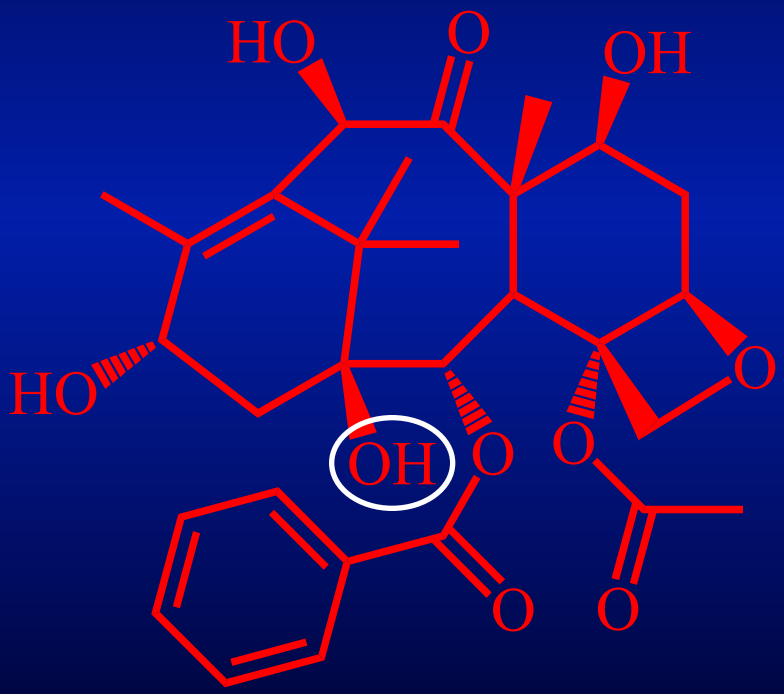
10-desacetylbaccatine III

Hémisynthèse du Taxol



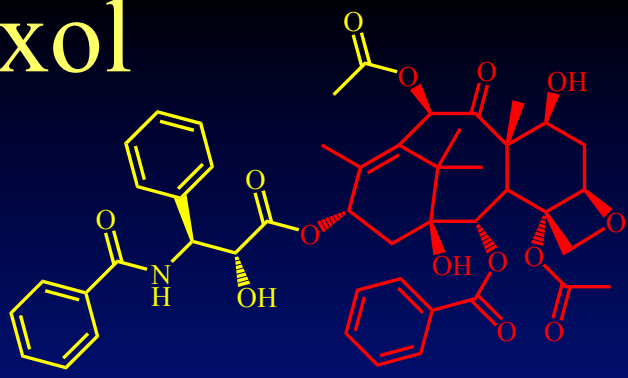
Taxol

Hydroxyle le moins réactif :



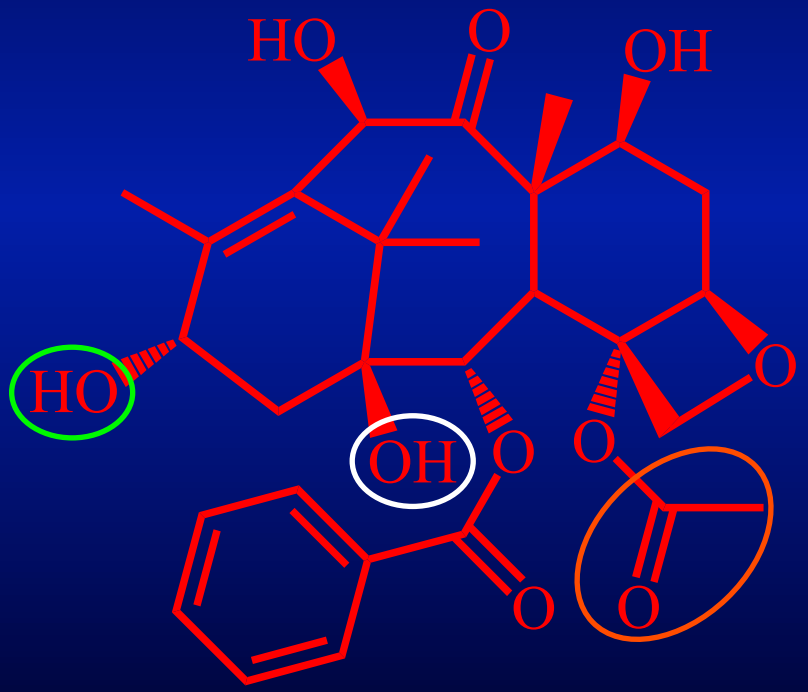
10-desacetylbaccatine III

Hémisynthèse du Taxol



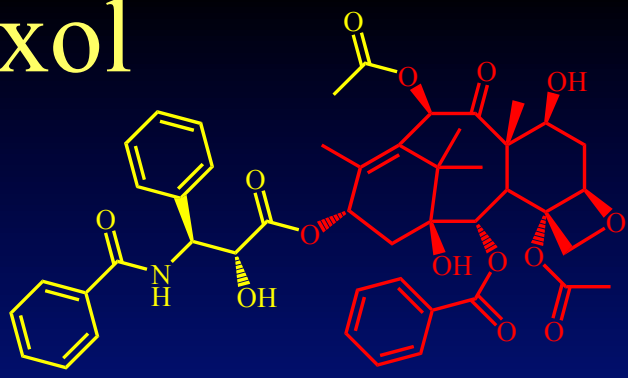
Taxol

2ème Hydroxyle
le moins réactif :



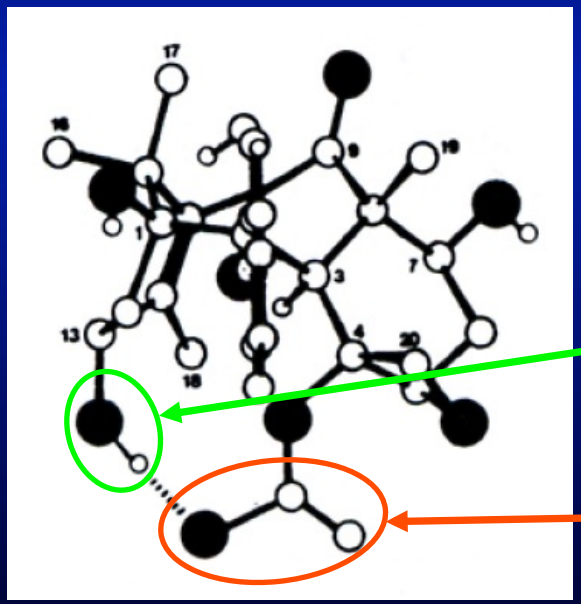
10-desacetylbaccatine III

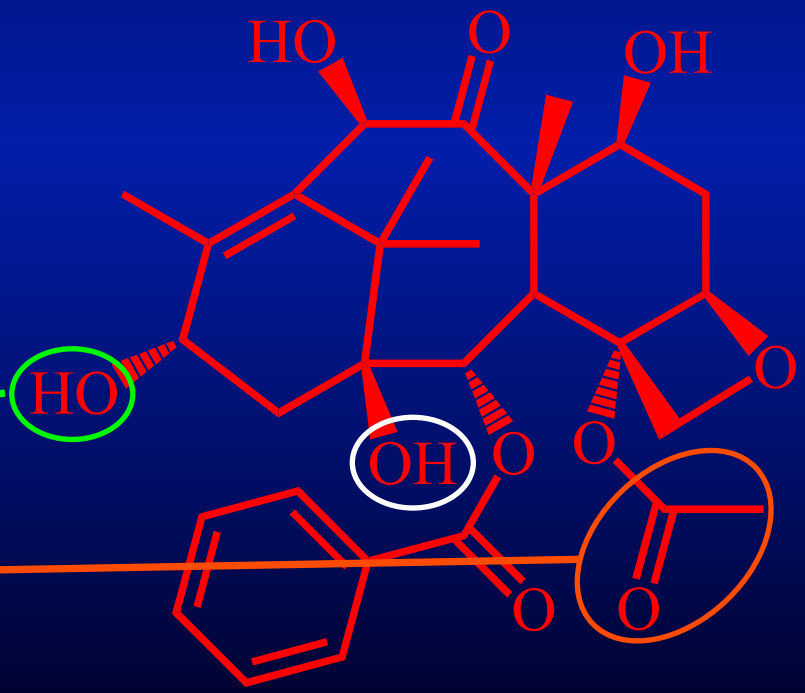
Hémisynthèse du Taxol



Taxol

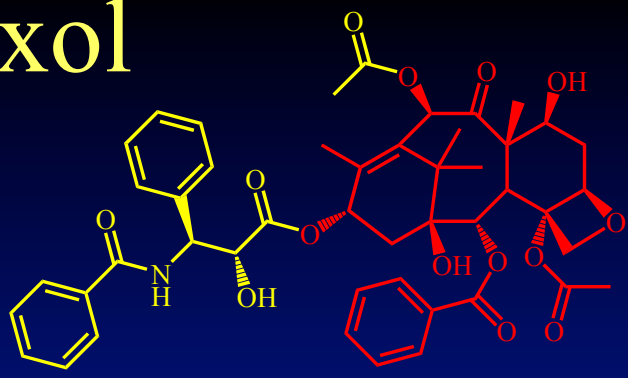
2ème Hydroxyle
le moins réactif :



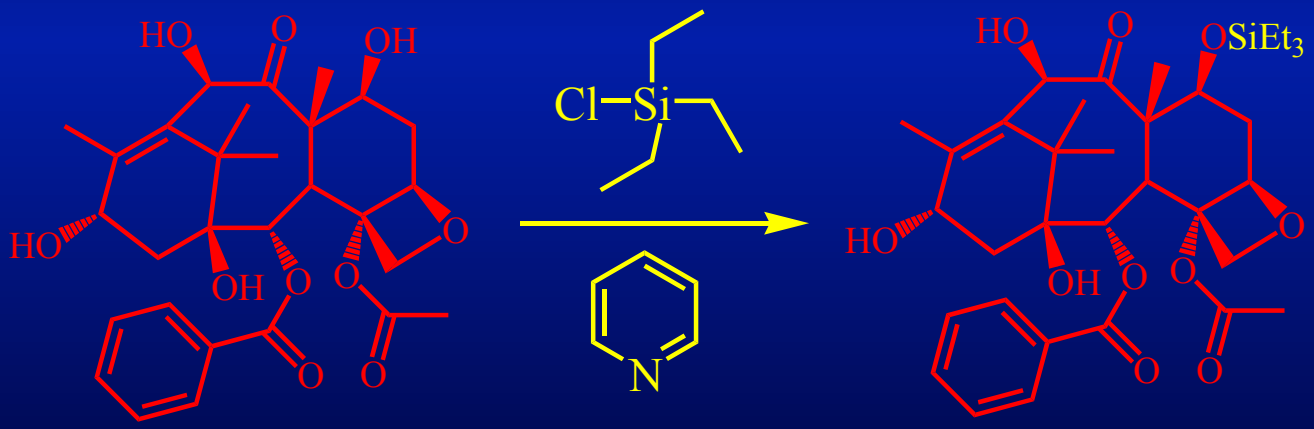


10-desacetylbaccatine III

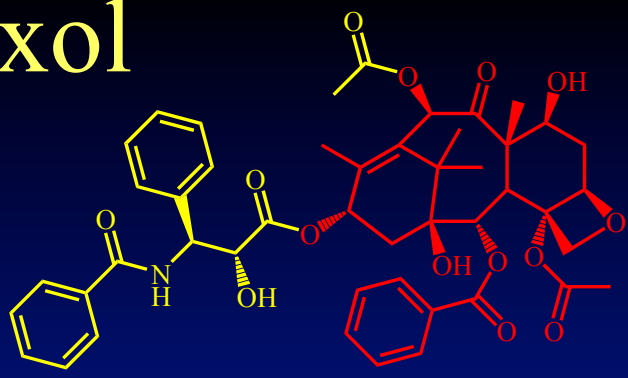
Hémisynthèse du Taxol



Taxol



Hémisynthèse du Taxol



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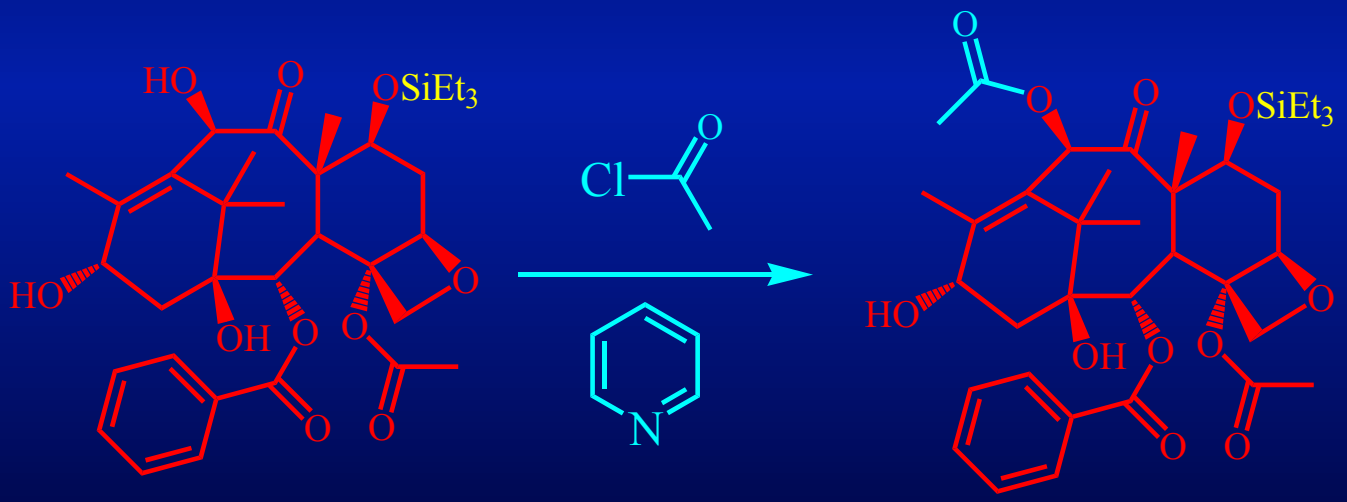

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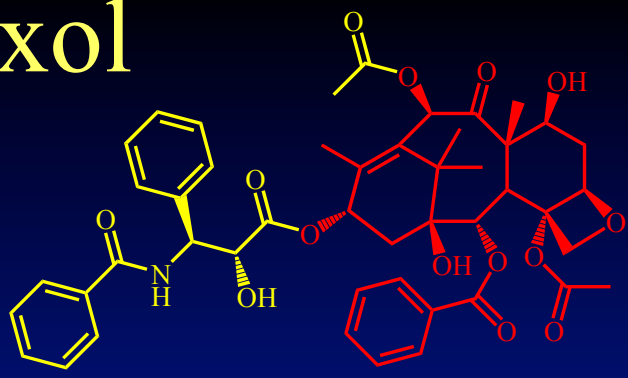

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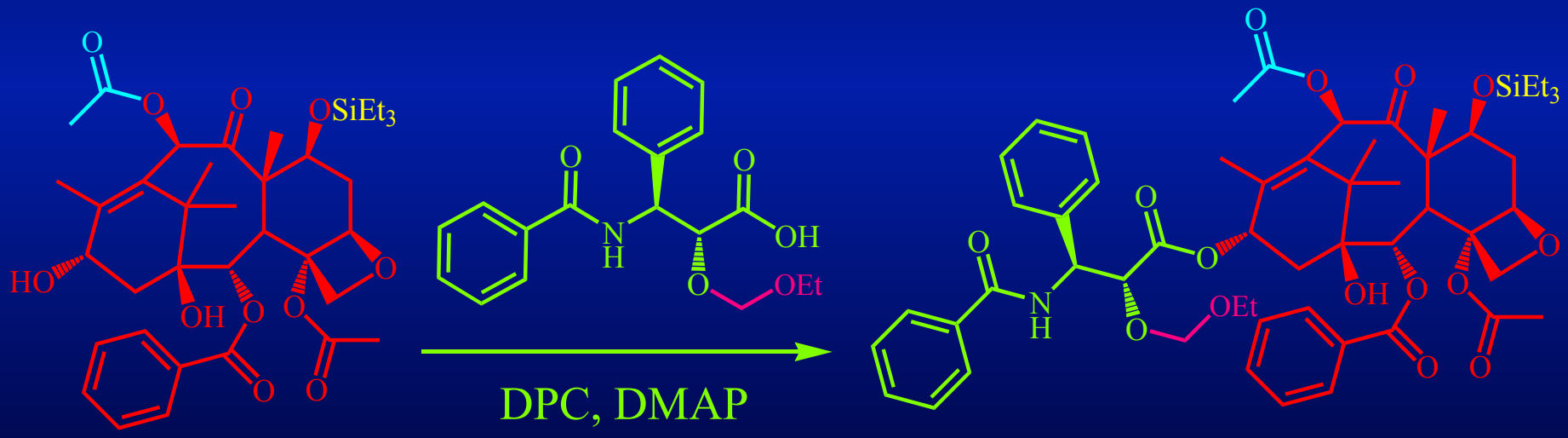

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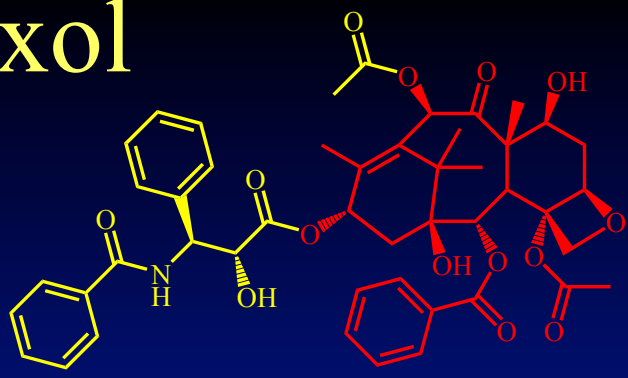

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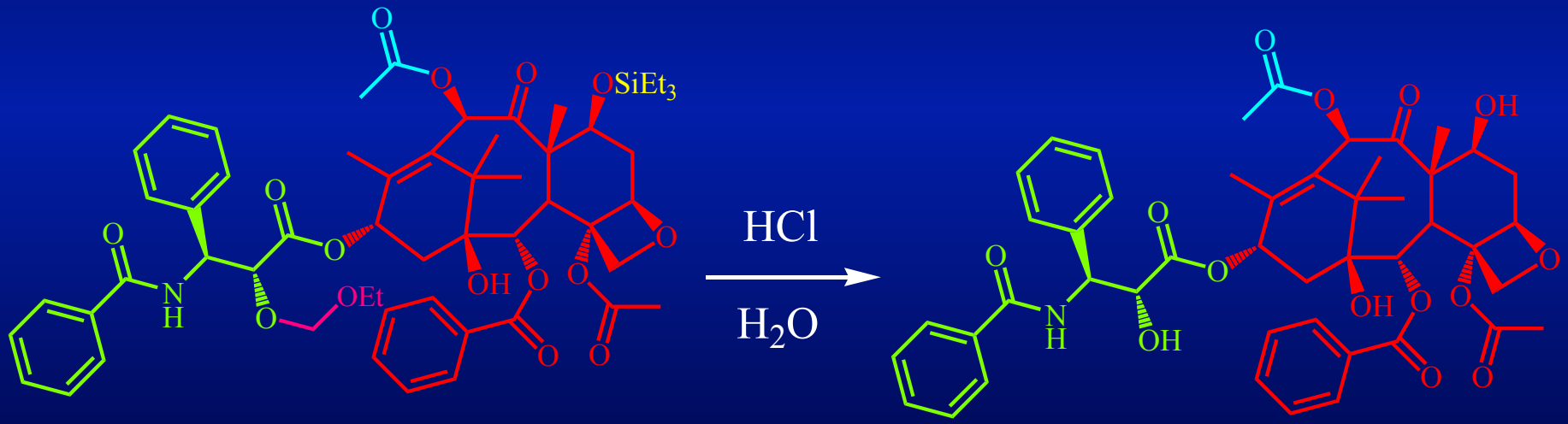
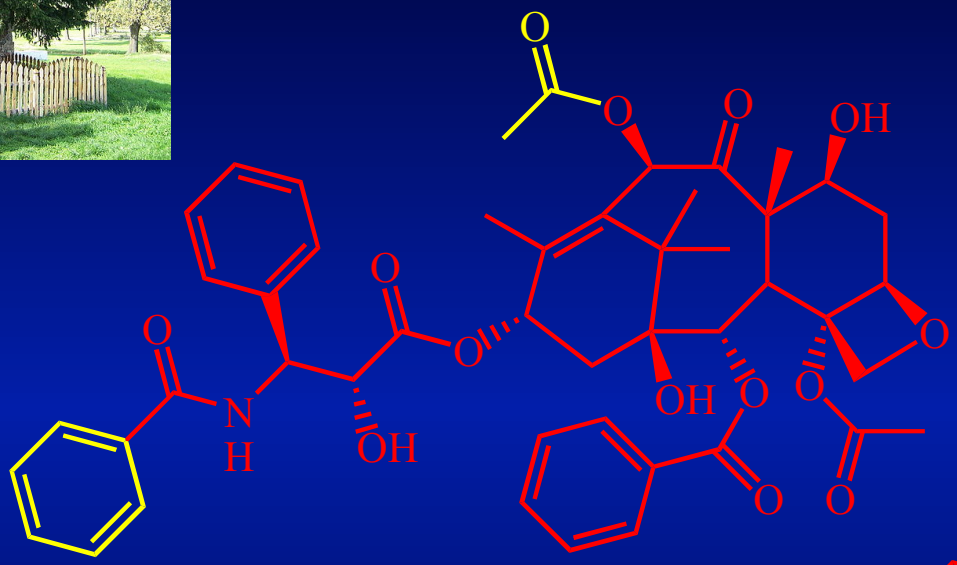
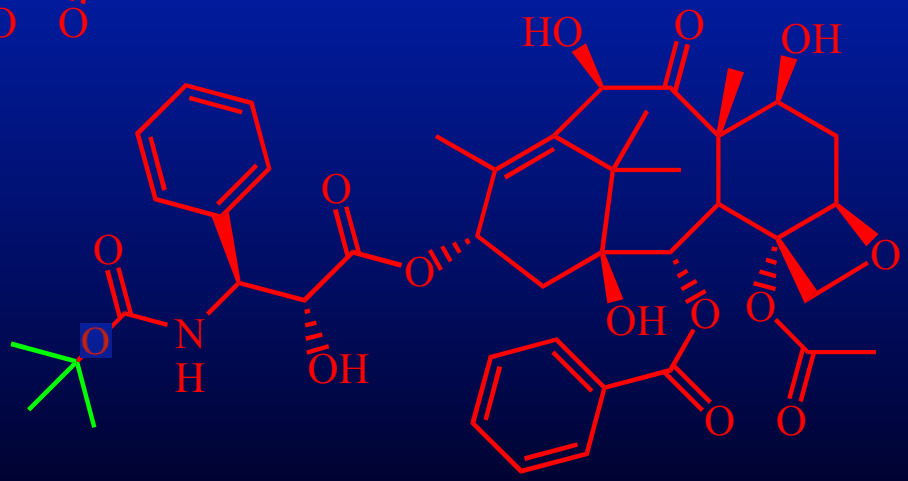


Analogues du Taxol



Taxol



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