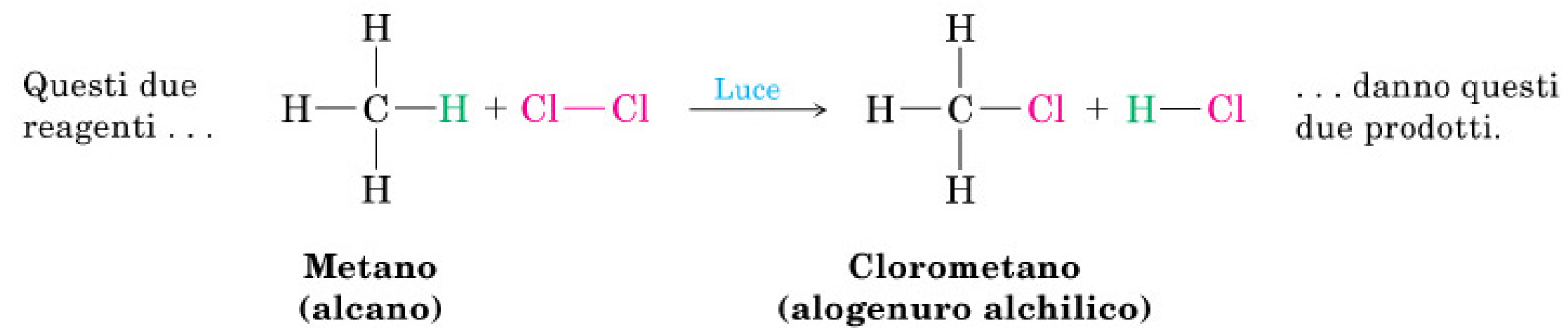
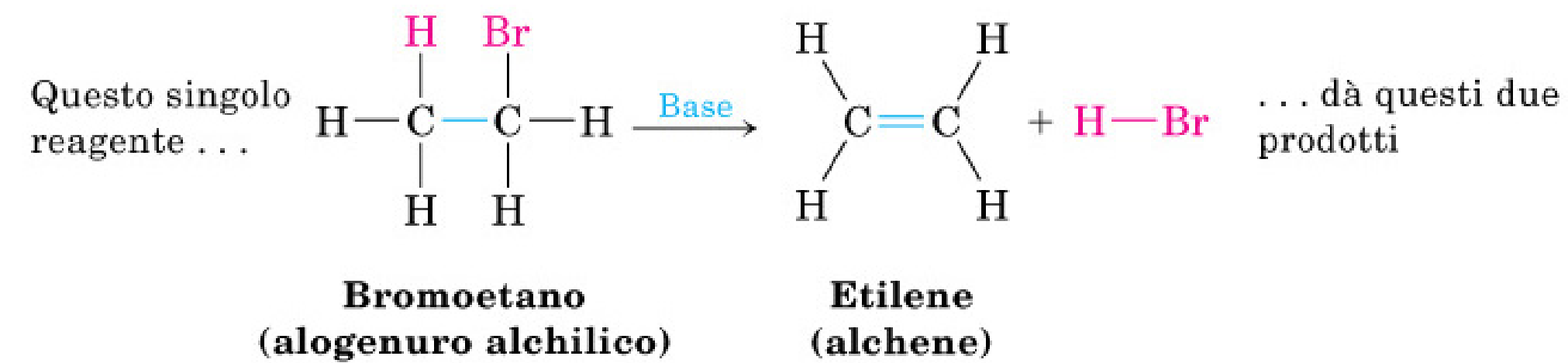
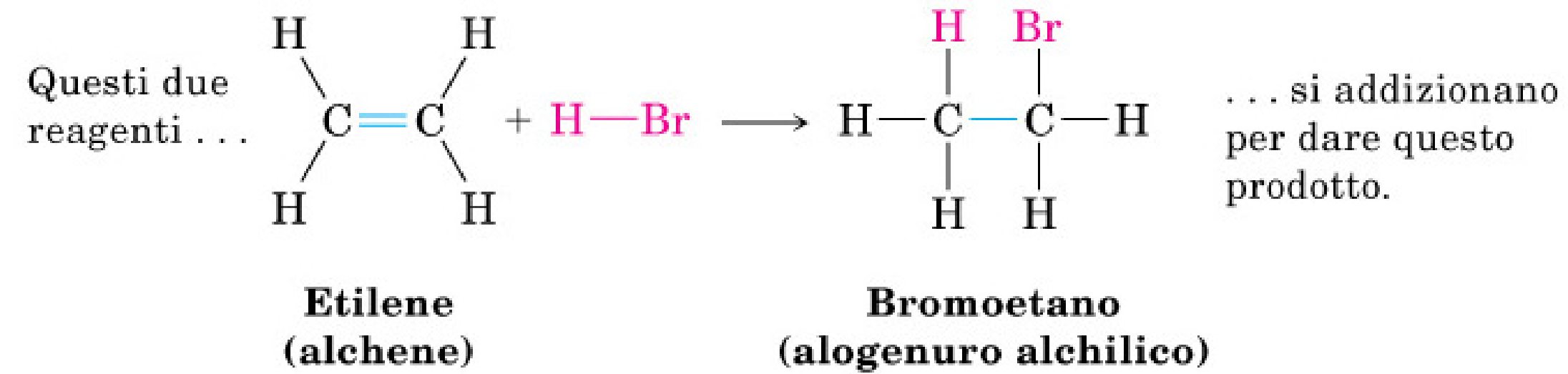


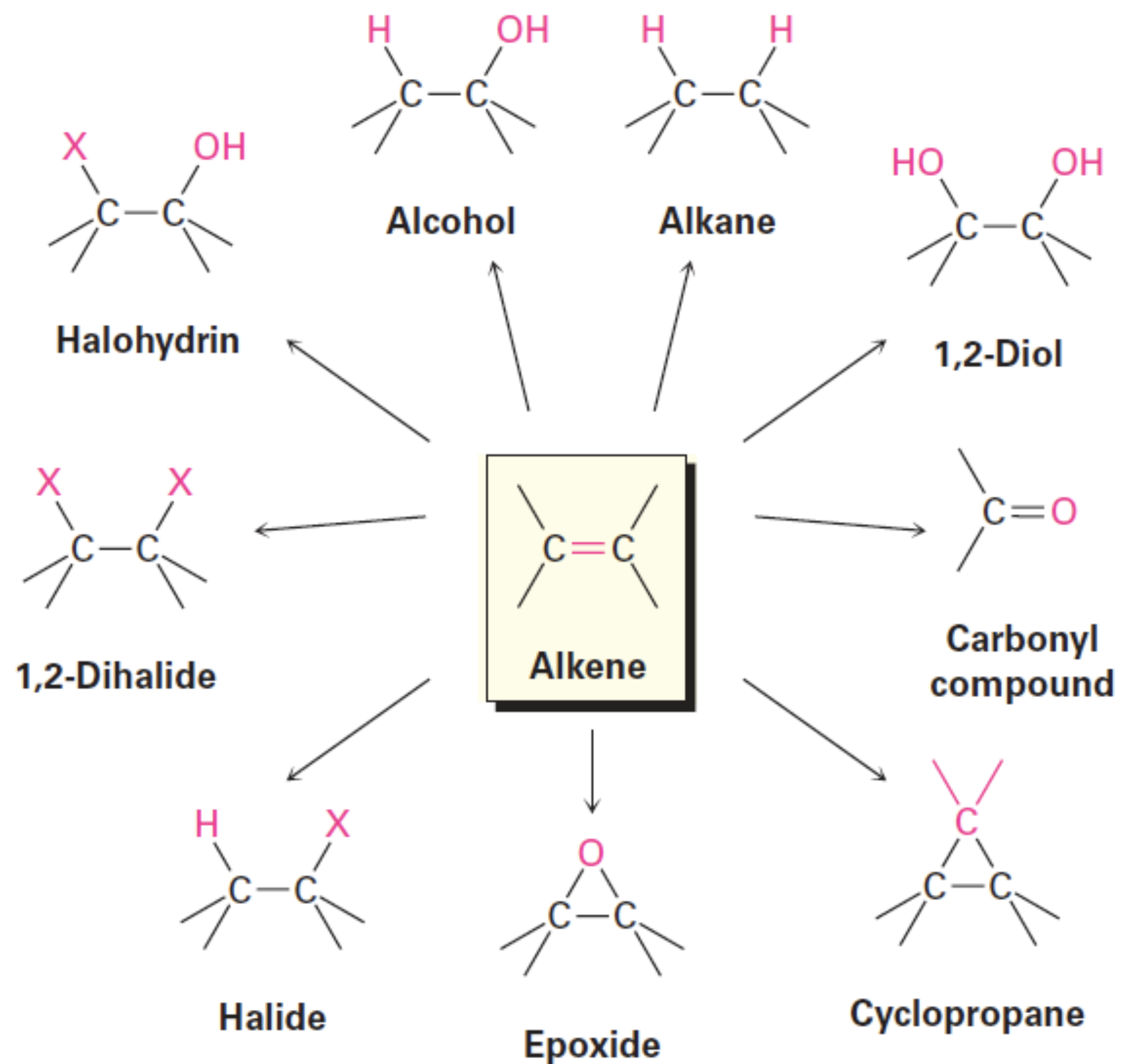
6B. Le reazioni degli alcheni

- (1) Addizione di acqua e acidi alogenidrici agli alcheni. Stabilità dei carbocationi.
- (2) Trasposizione dei carbocationi.
- (3) Regioselettività delle reazioni di addizione elettrofila (Regola di Markovnikov).
- (4) Addizione radicalica (anti-Markovnikov).
- (5) Idroborazione-ossidazione degli alcheni.
- (6) Addizione di alogeni agli alcheni.
- (7) Addizione di un perossiacido agli alcheni (epossidazione).
- (8) Addizione di ozono agli alcheni (ozonolisi).
- (9) Stereochimica delle reazioni di addizione agli alcheni: reazione regioselettiva, stereoselettiva o stereospecifica.

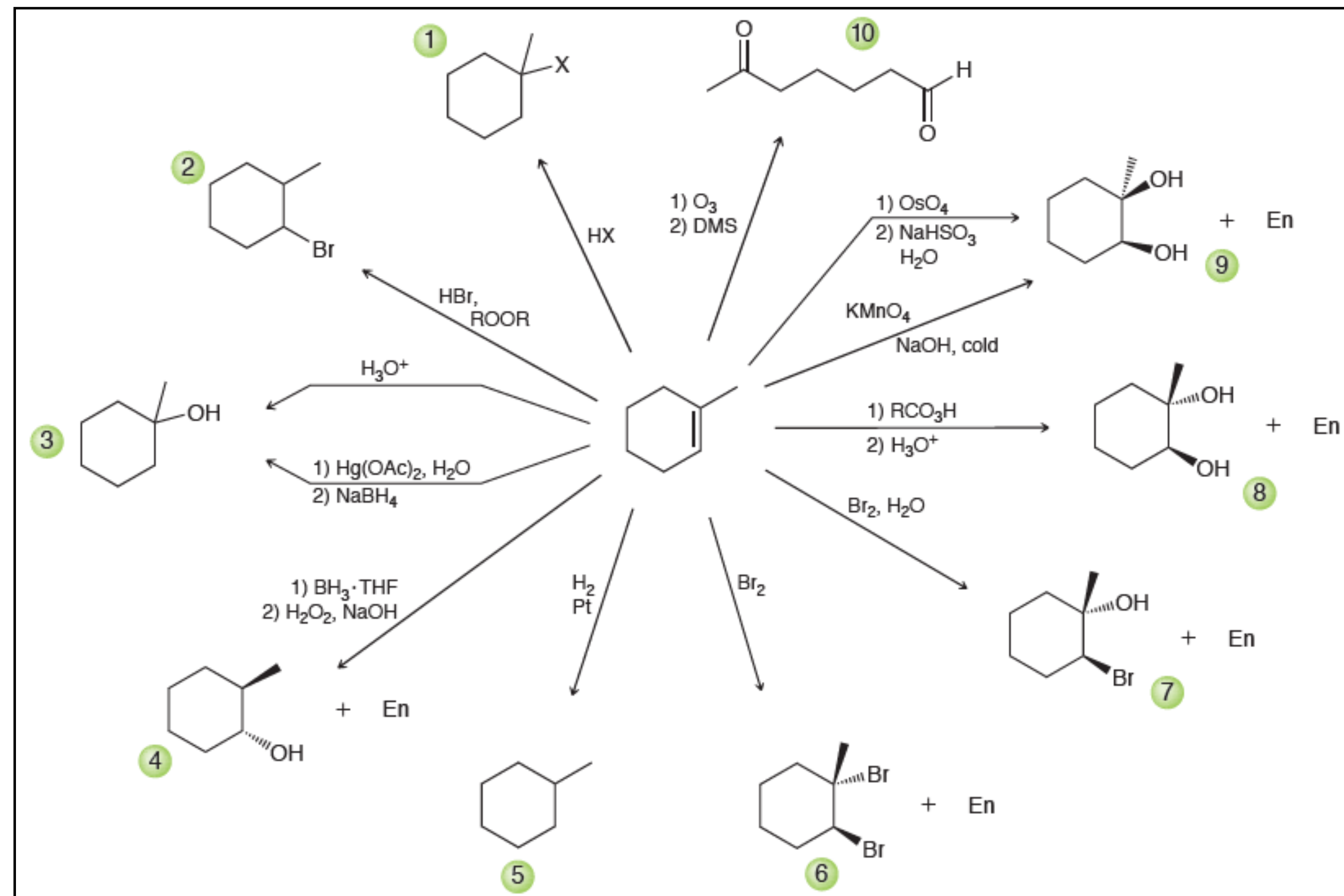
Tipi di reazioni organiche: Addizione, eliminazione e sostituzione.



Le reazioni degli alcheni



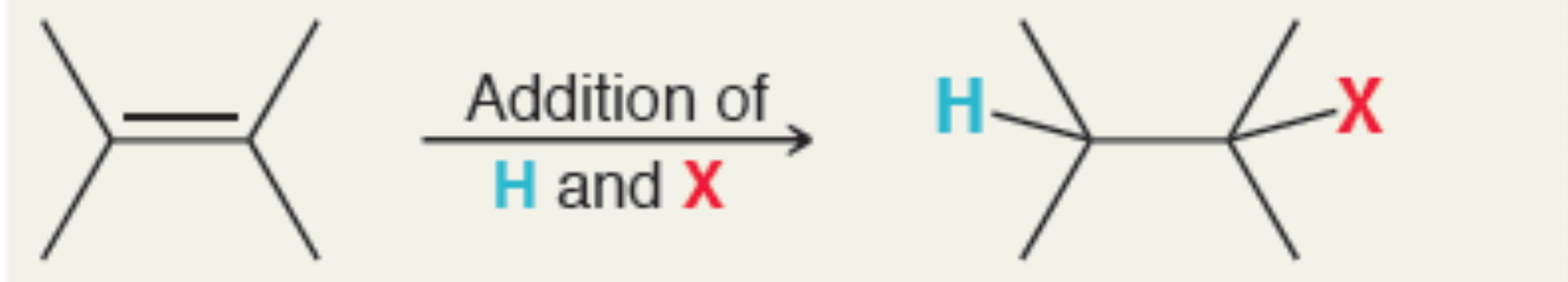
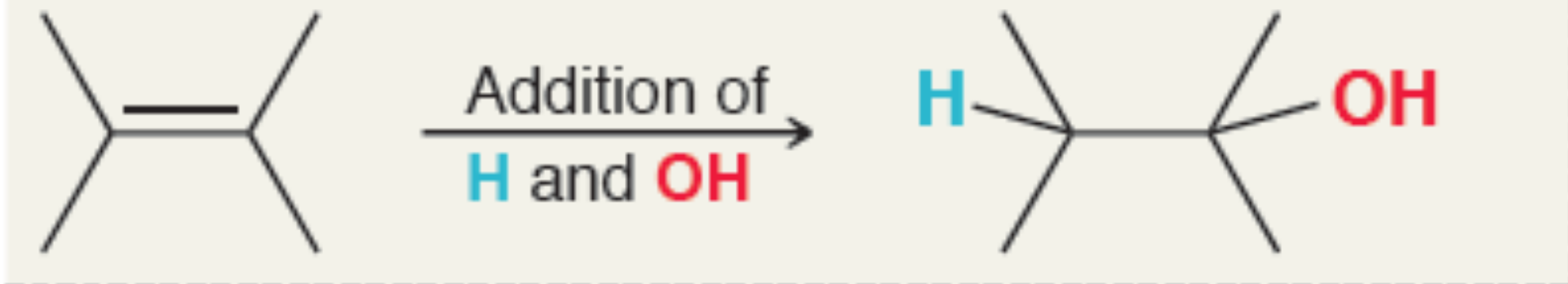
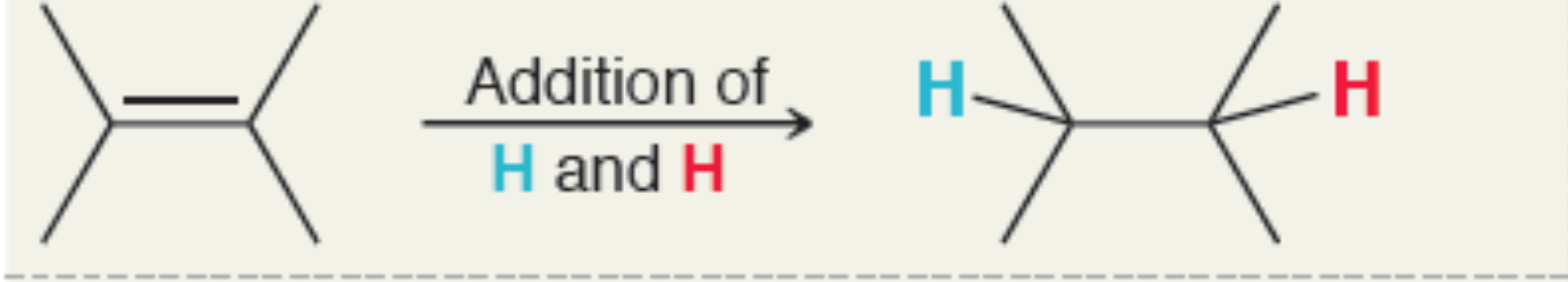
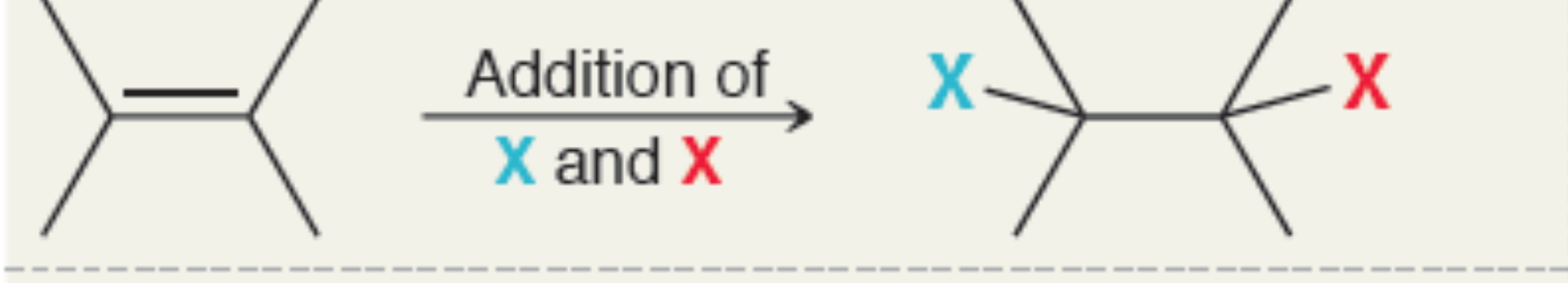
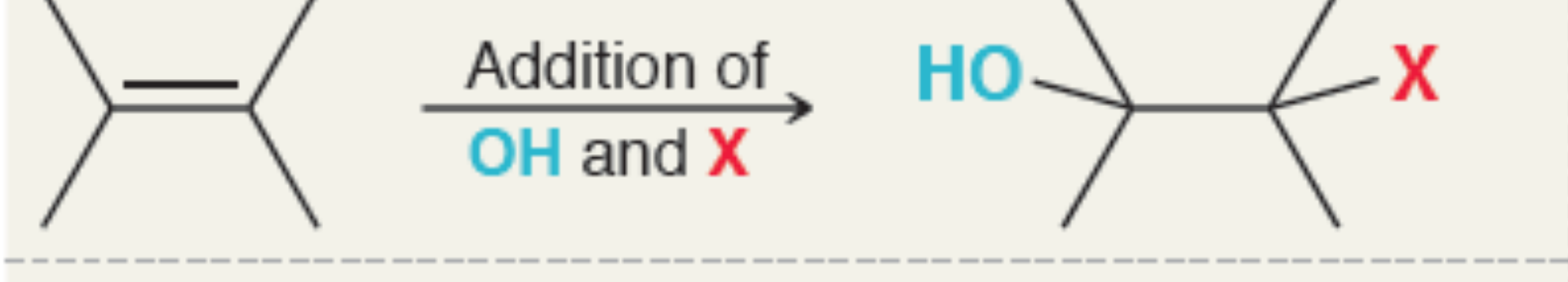
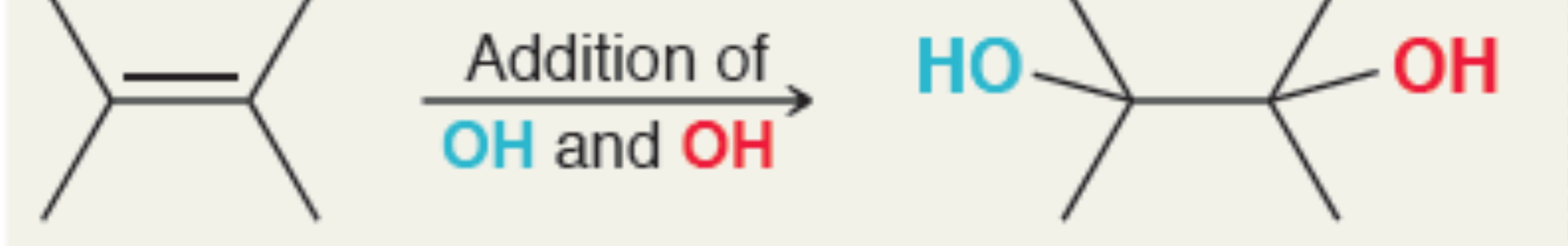
Le reazioni degli alcheni



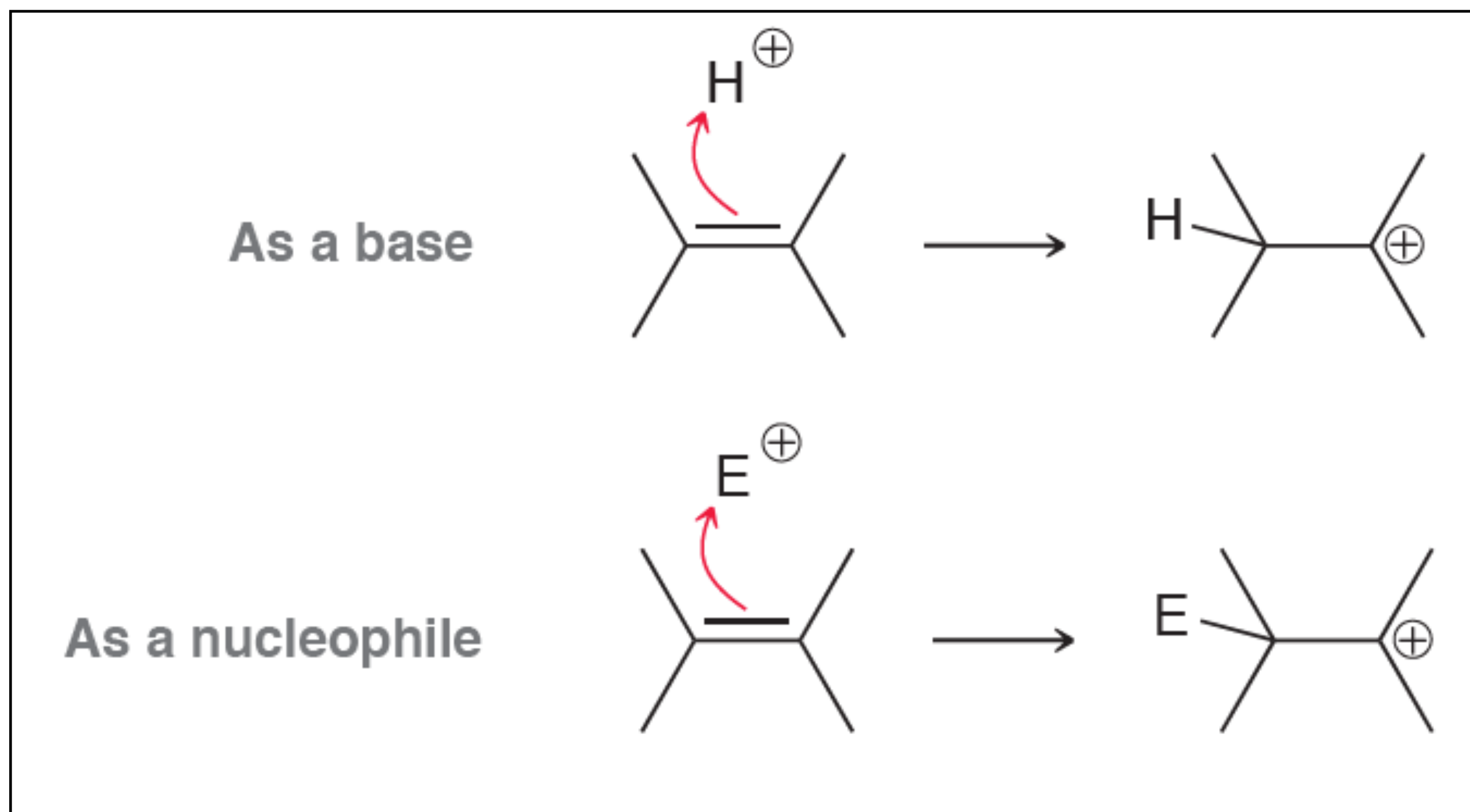
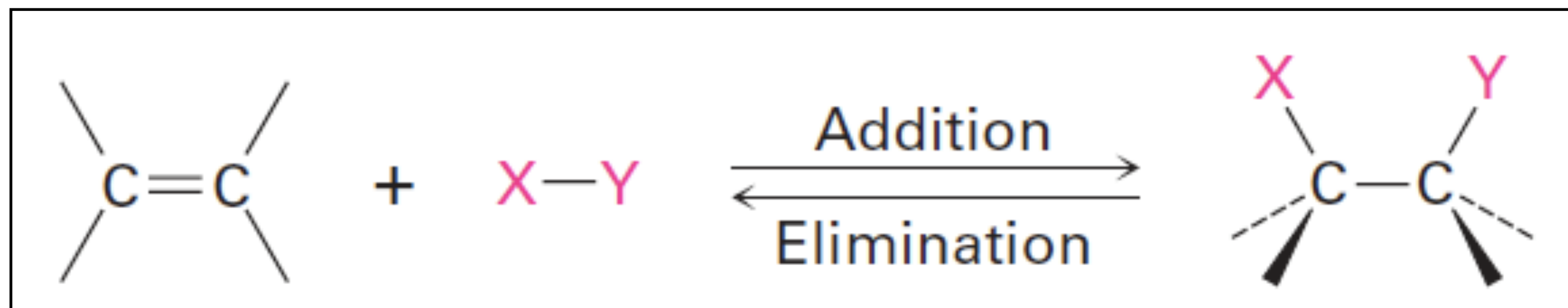
- | | | |
|---|-----------------------------------|--------------------------------|
| 1. Hydrohalogenation (Markovnikov) | 4. Hydroboration-oxidation | 8. Anti dihydroxylation |
| 2. Hydrohalogenation (<i>anti</i> -Markovnikov) | 5. Hydrogenation | 9. Syn dihydroxylation |
| 3. Acid-catalyzed hydration and oxymercuration-demercuration | 6. Bromination | 10. Ozonolysis |
| | 7. Halohydrin formation | |

Le reazioni degli alcheni

TABLE 9.1 SOME COMMON TYPES OF ADDITION REACTIONS

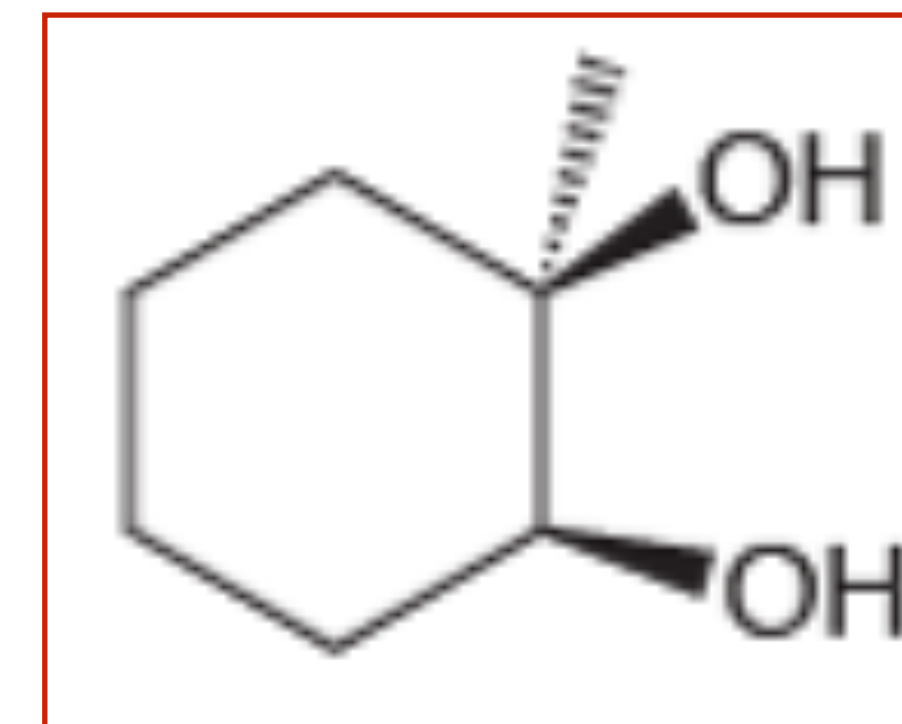
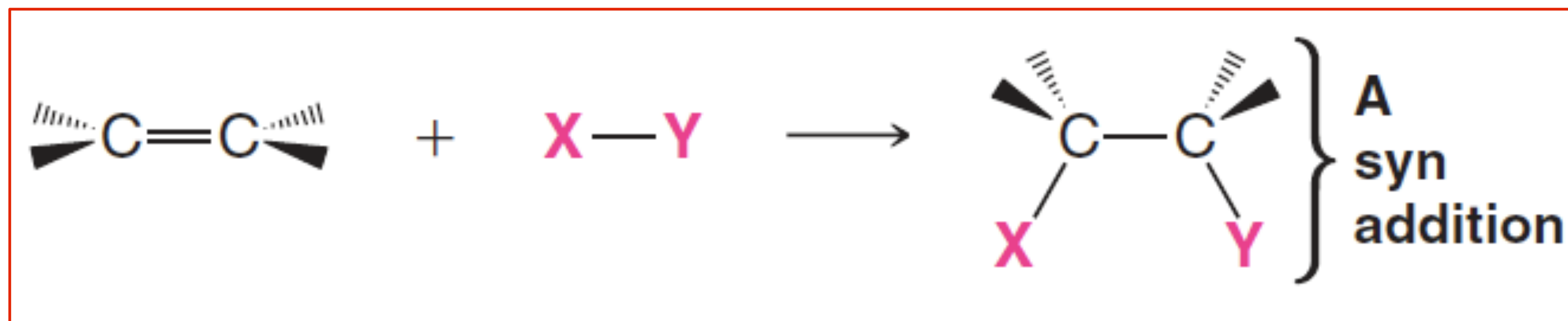
TYPE OF ADDITION REACTION	NAME
	Hydrohalogenation (X =Cl, Br, or I)
	Hydration
	Hydrogenation
	Halogenation (X =Cl or Br)
	Halohydrin formation (X =Cl, Br, or I)
	Dihydroxylation

Le reazioni degli alcheni

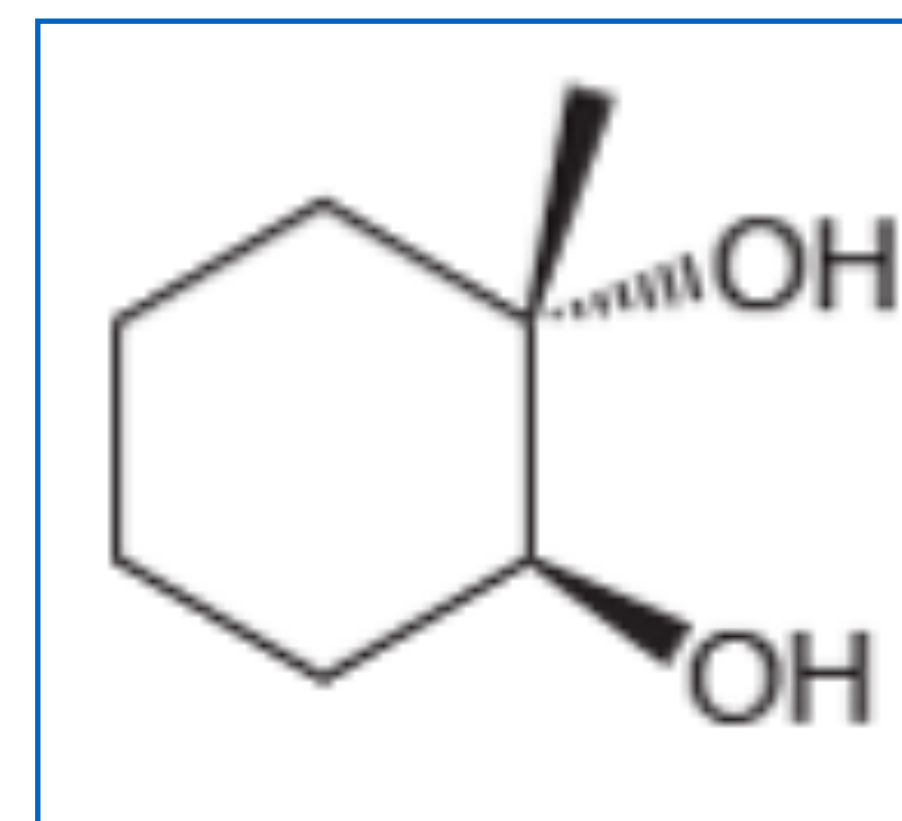
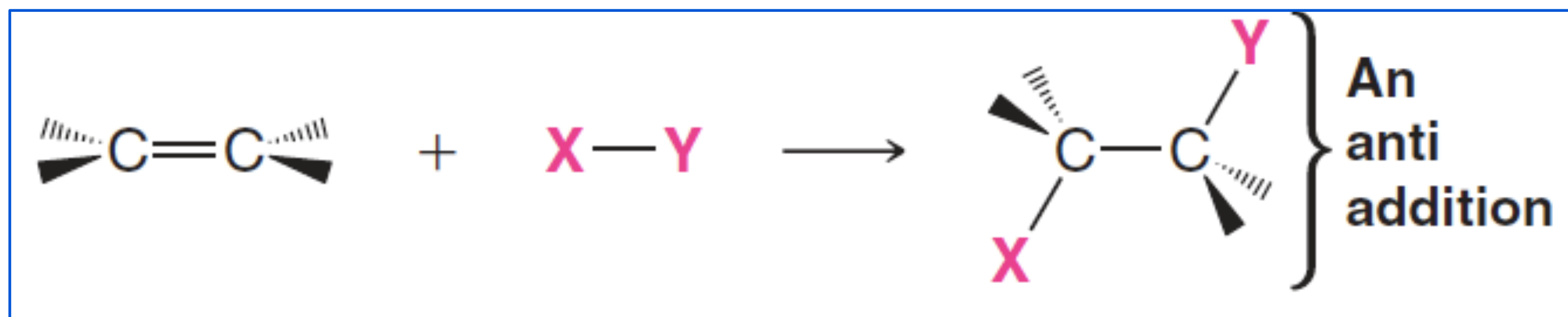


Le reazioni degli alcheni

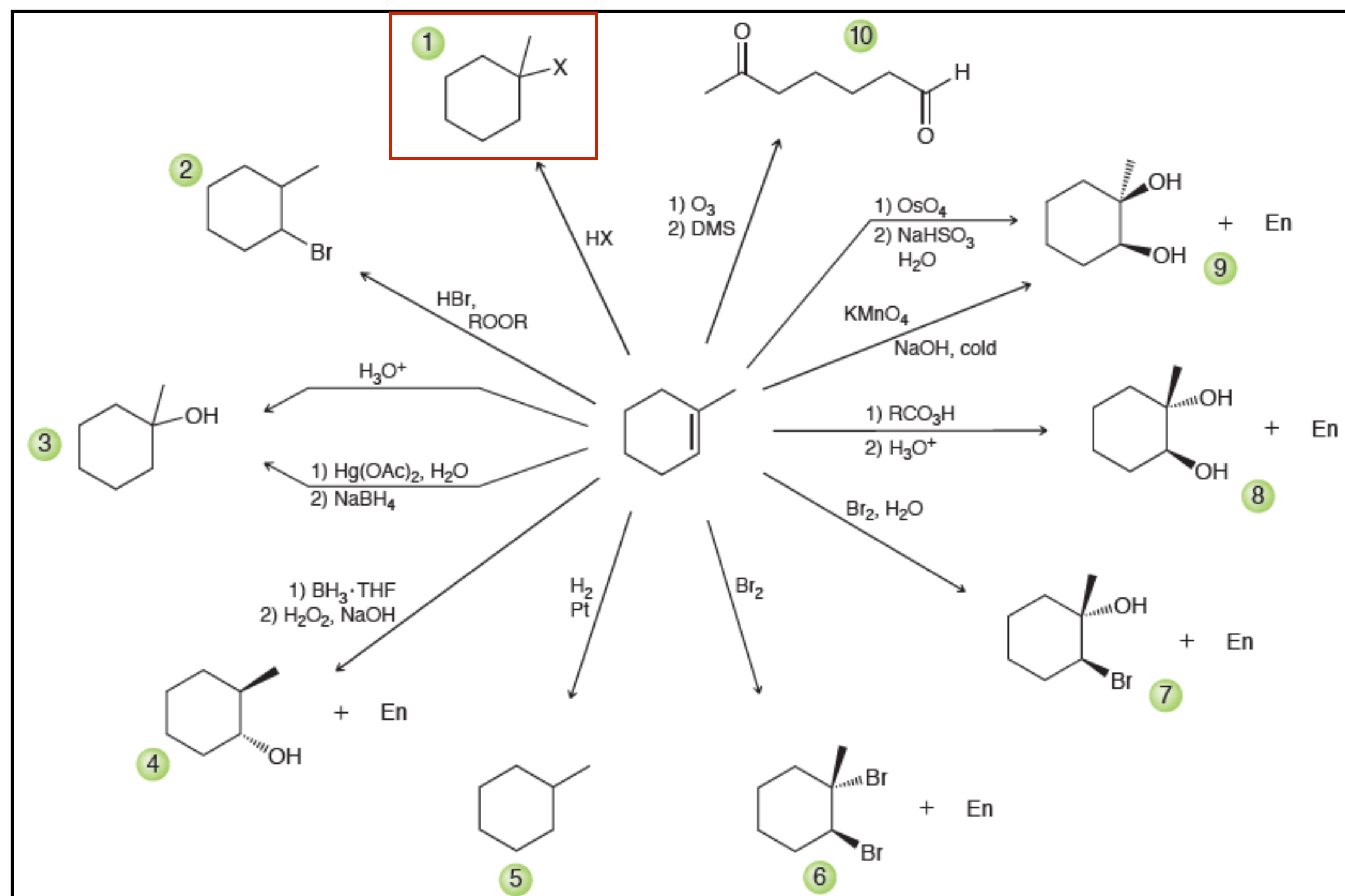
Adição à ligação Dupla SIN



Adição à ligação Dupla ANTI



Le reazioni degli alcheni



1. Hydrohalogenation (Markovnikov)

2. Hydrohalogenation (anti-Markovnikov)

3. Acid-catalyzed hydration and oxymercuration-demercuration

4. Hydroboration-oxidation

5. Hydrogenation

6. Bromination

7. Halohydrin formation

8. Anti dihydroxylation

9. Syn dihydroxylation

10. Ozonolysis

Le reazioni degli alcheni • La stereochimica delle reazioni di addizione

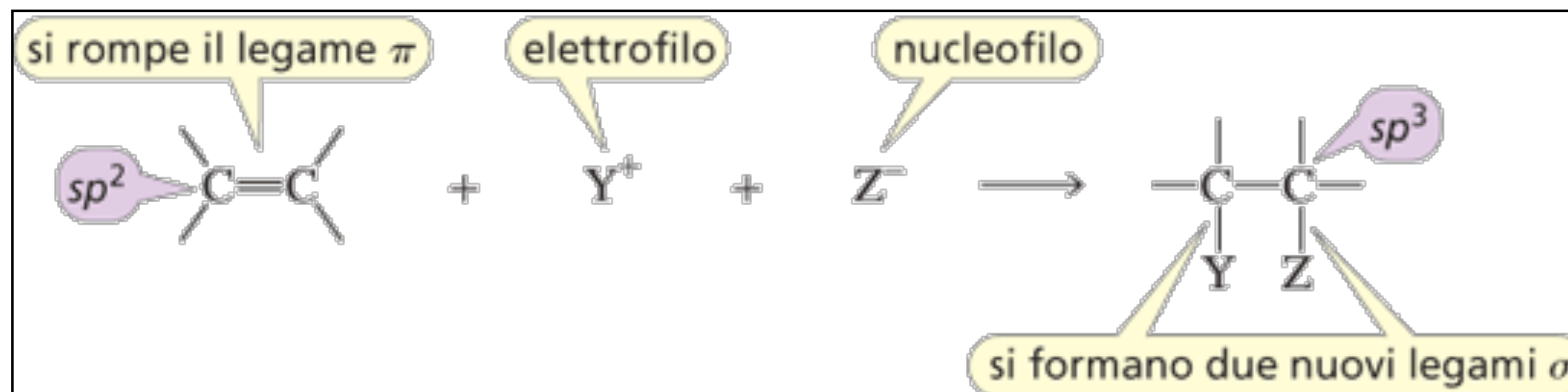
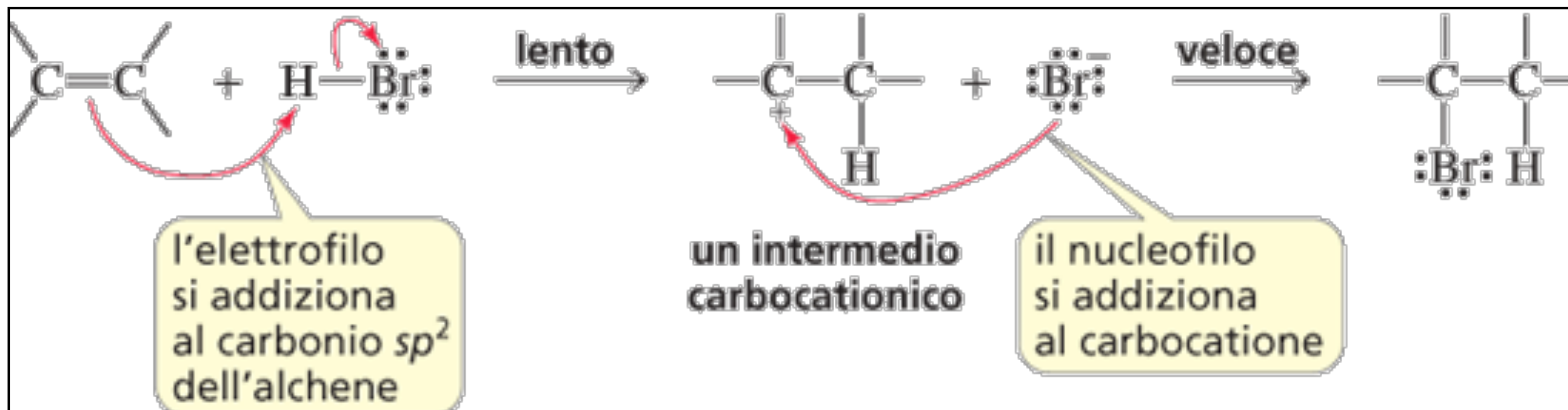


FIGURA 5.4 MECCANISMO: Reazione di addizione elettrofila di HBr all'etilene. La reazione avviene in due stadi che coinvolgono entrambi interazioni elettrofilo-nucleofilo.

L'HBr elettrofilo viene attaccato dagli elettroni π del doppio legame e si forma un nuovo legame σ C—H. Questo lascia l'altro atomo di carbonio con una carica $+$ ed un orbitale p vuoto.

Br^- dona una coppia di elettroni all'atomo di carbonio carico positivamente: si forma un legame σ C—Br e si ottiene il prodotto neutro di addizione.

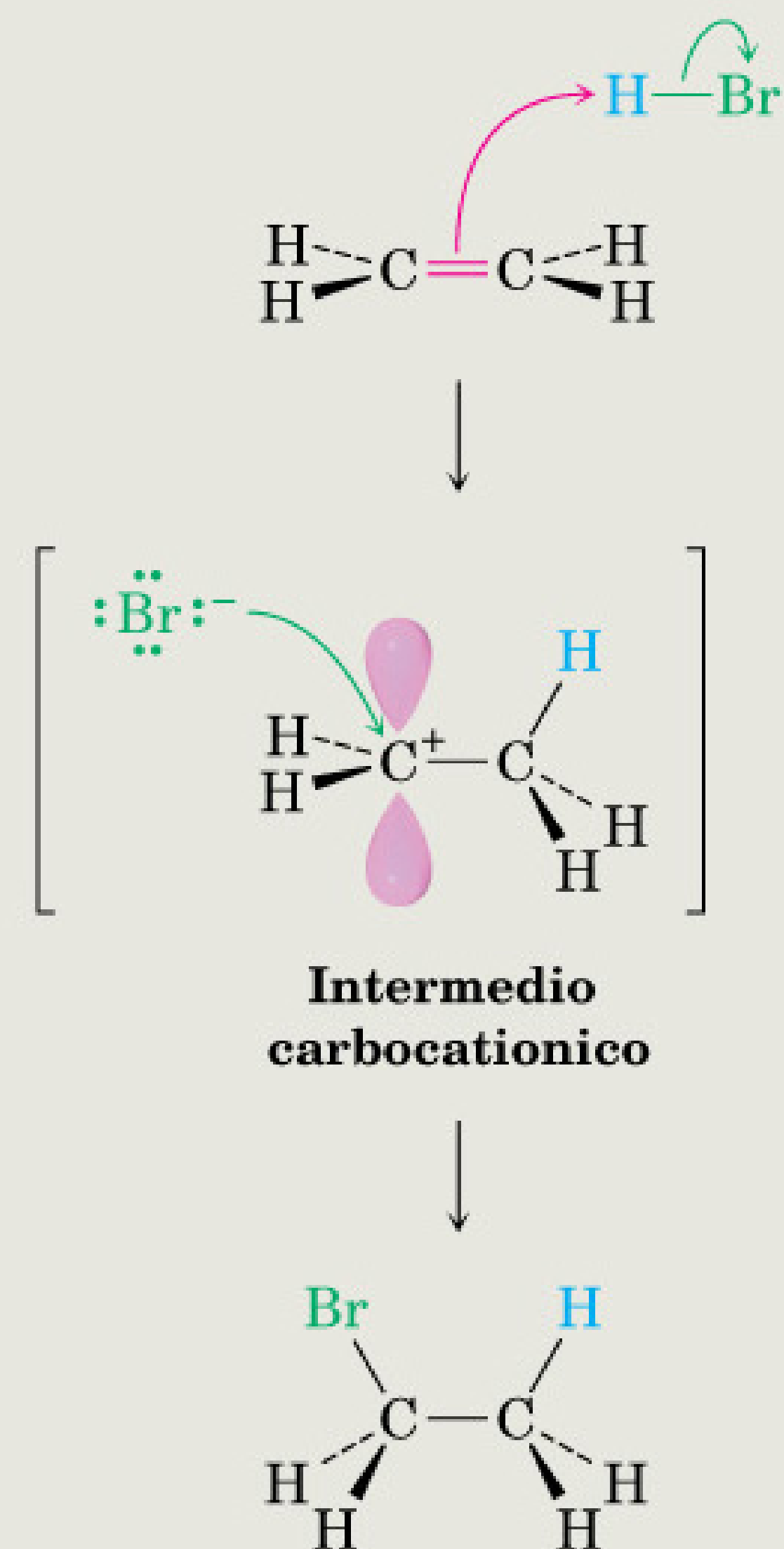
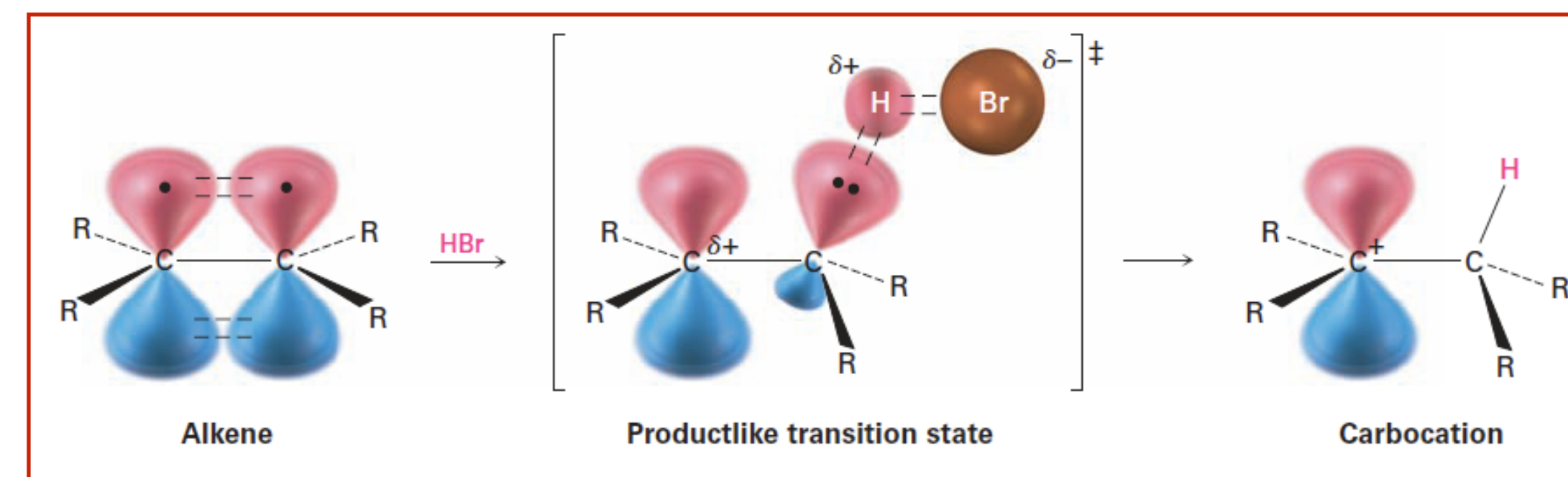
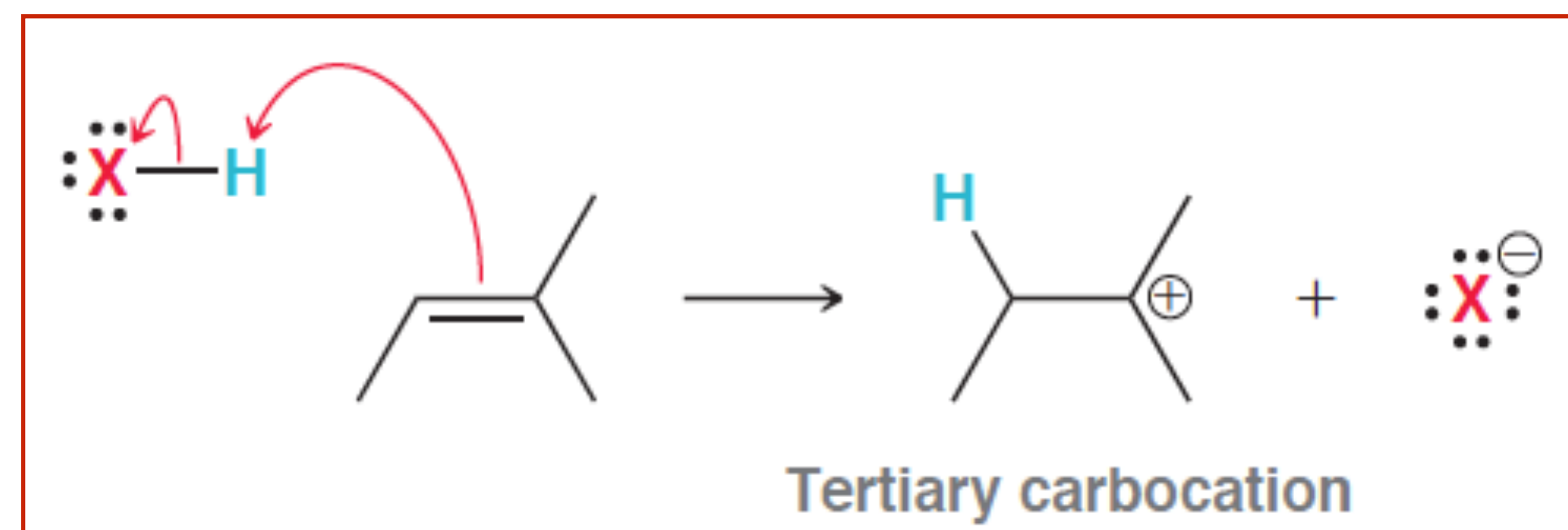
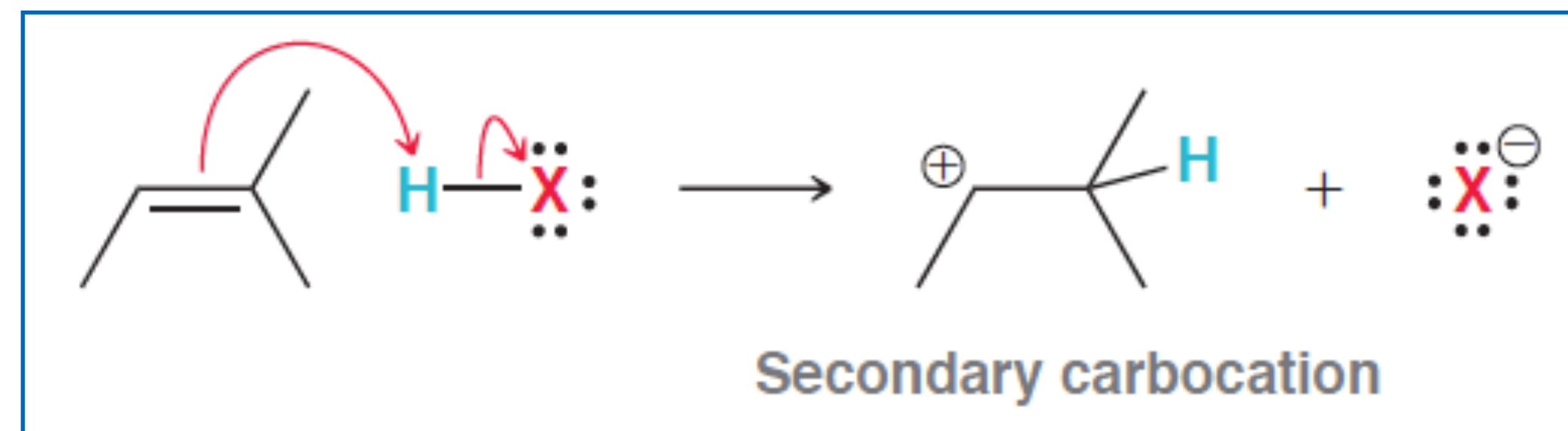
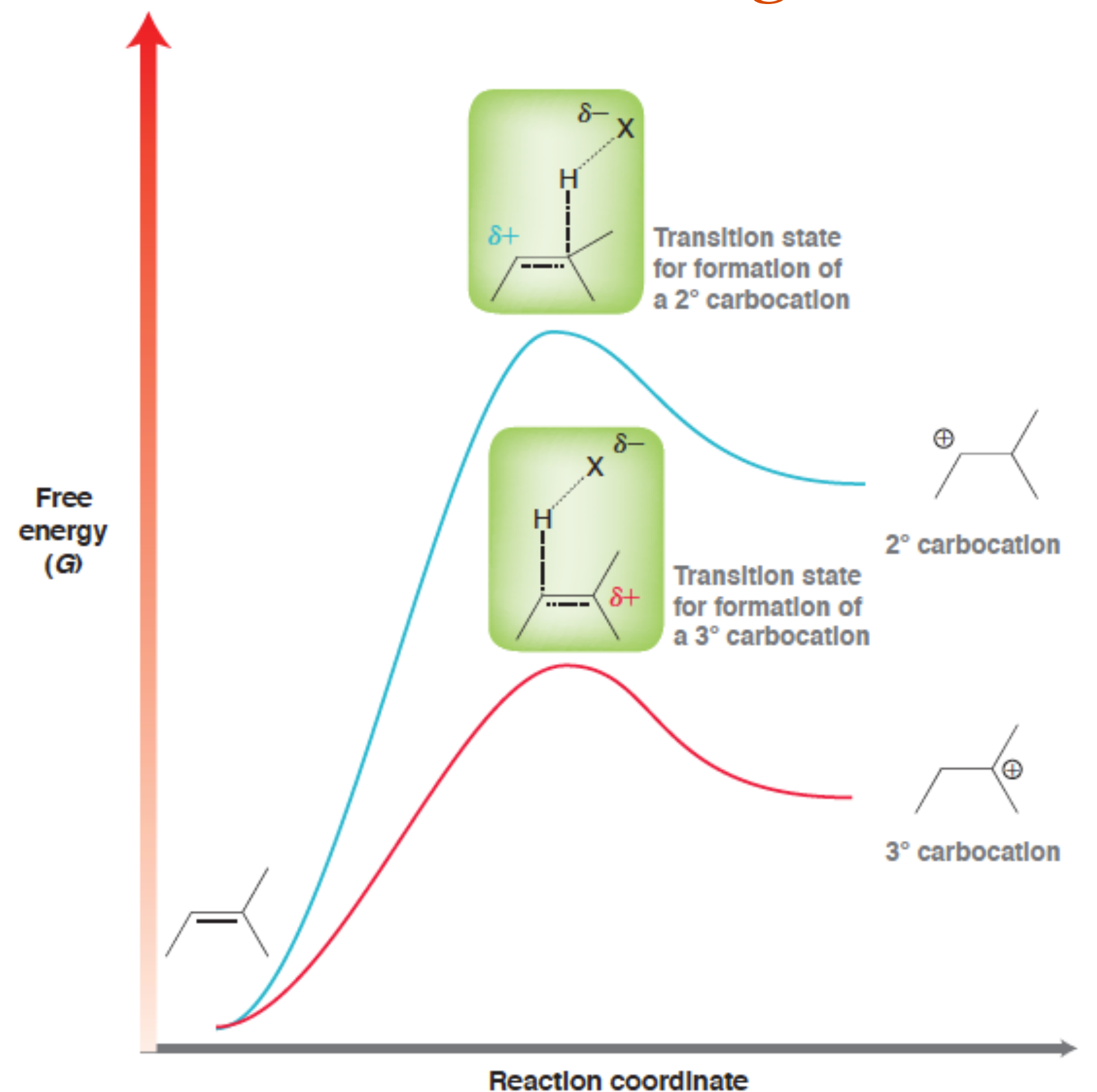
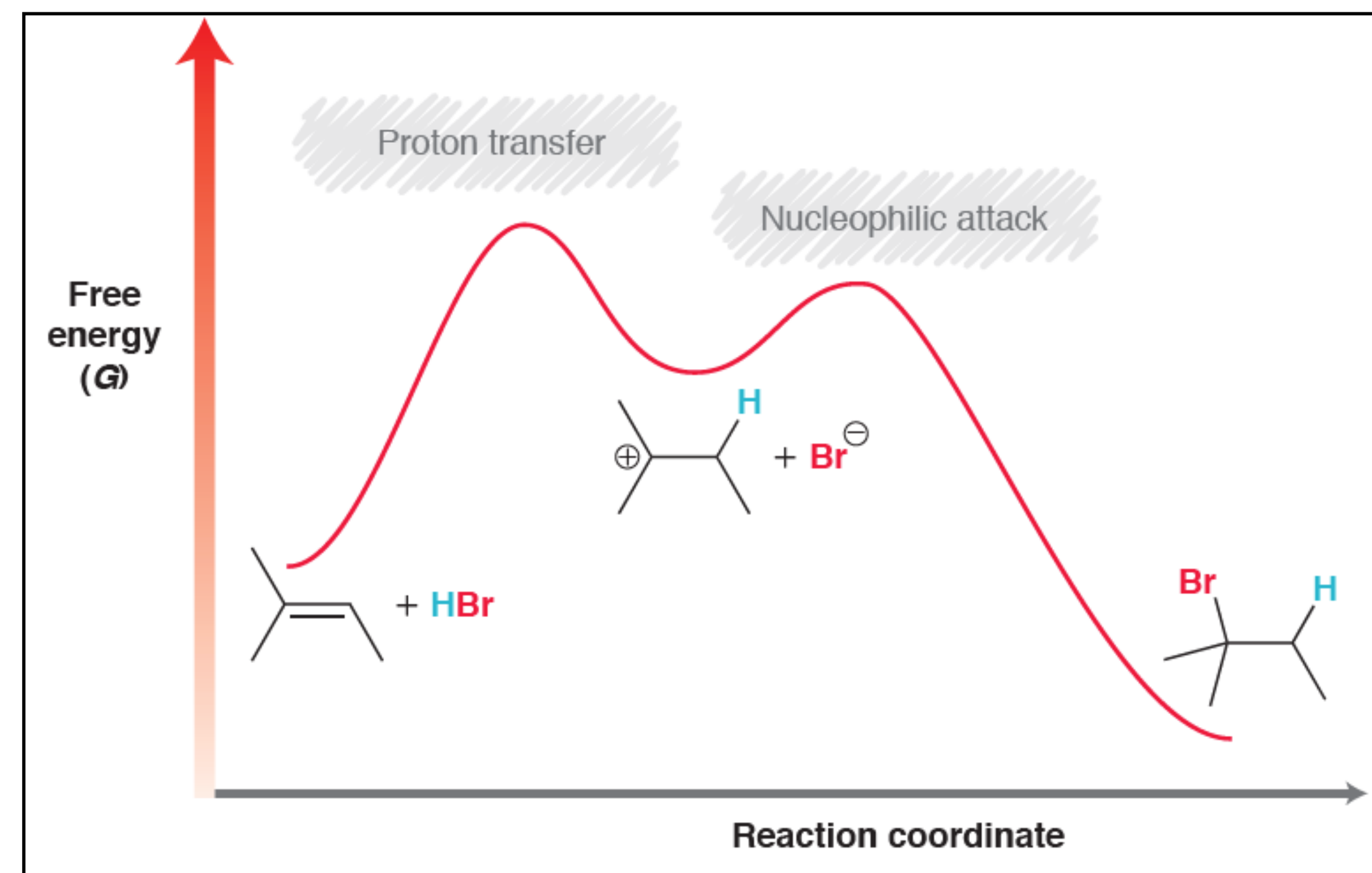
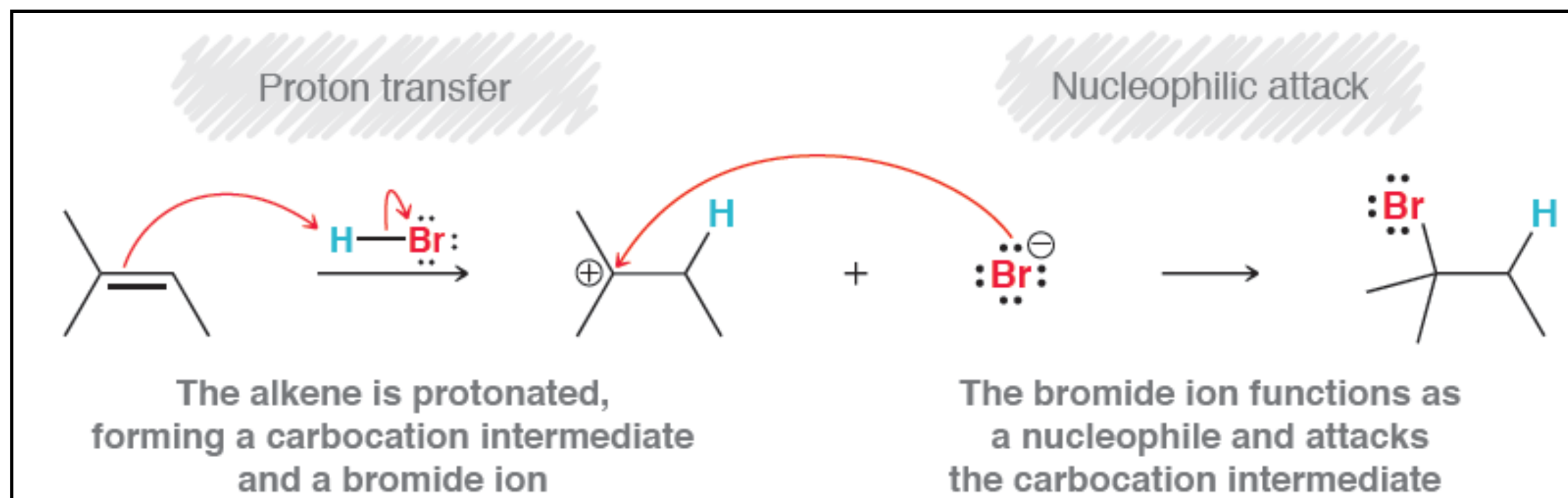
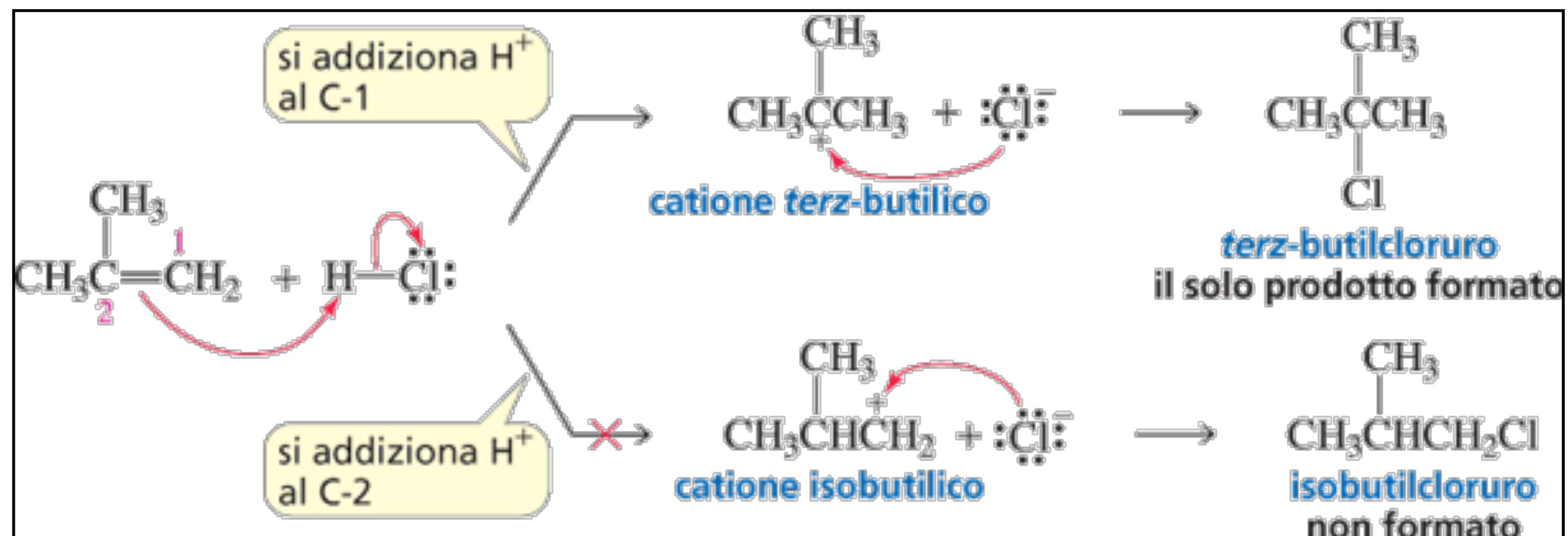
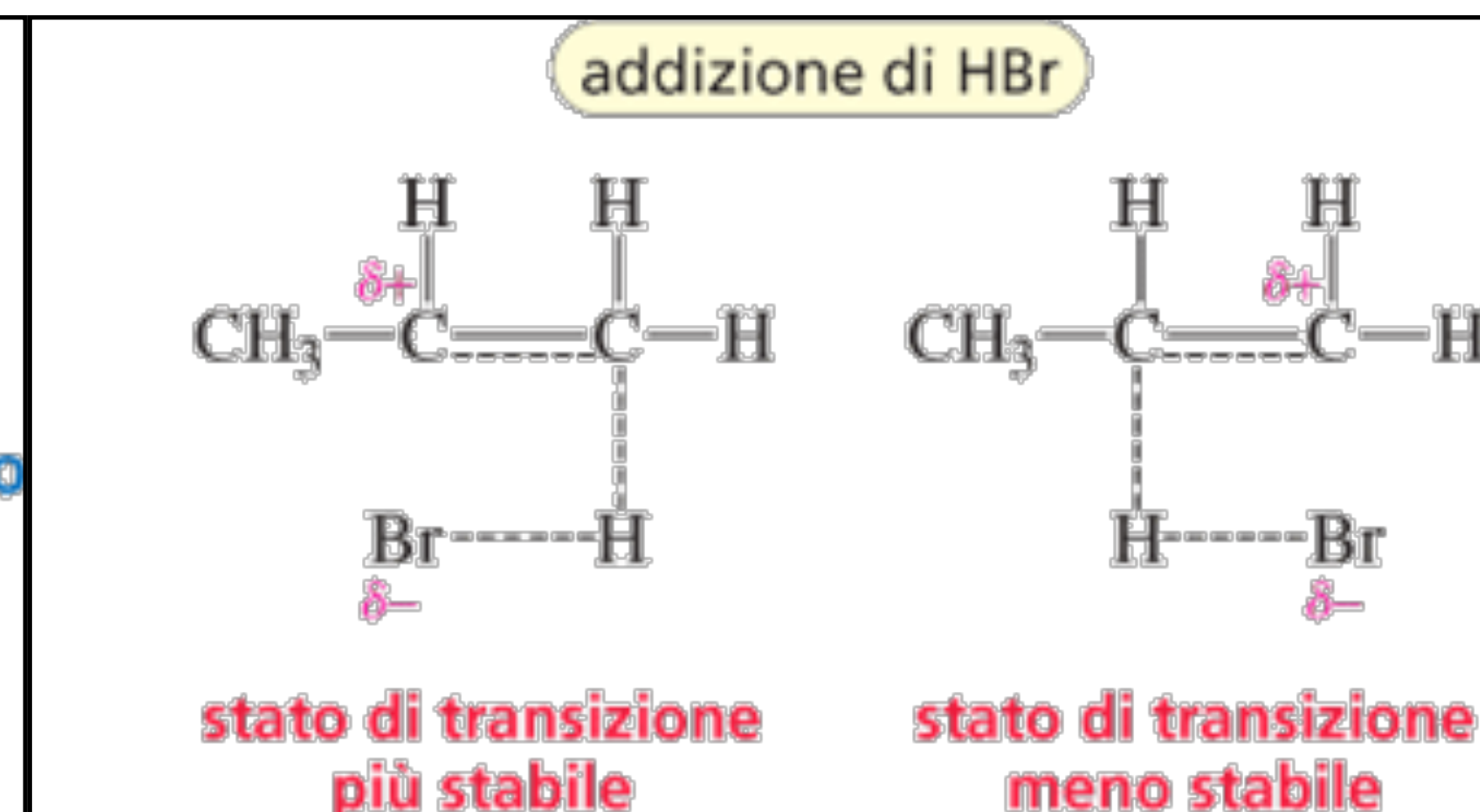
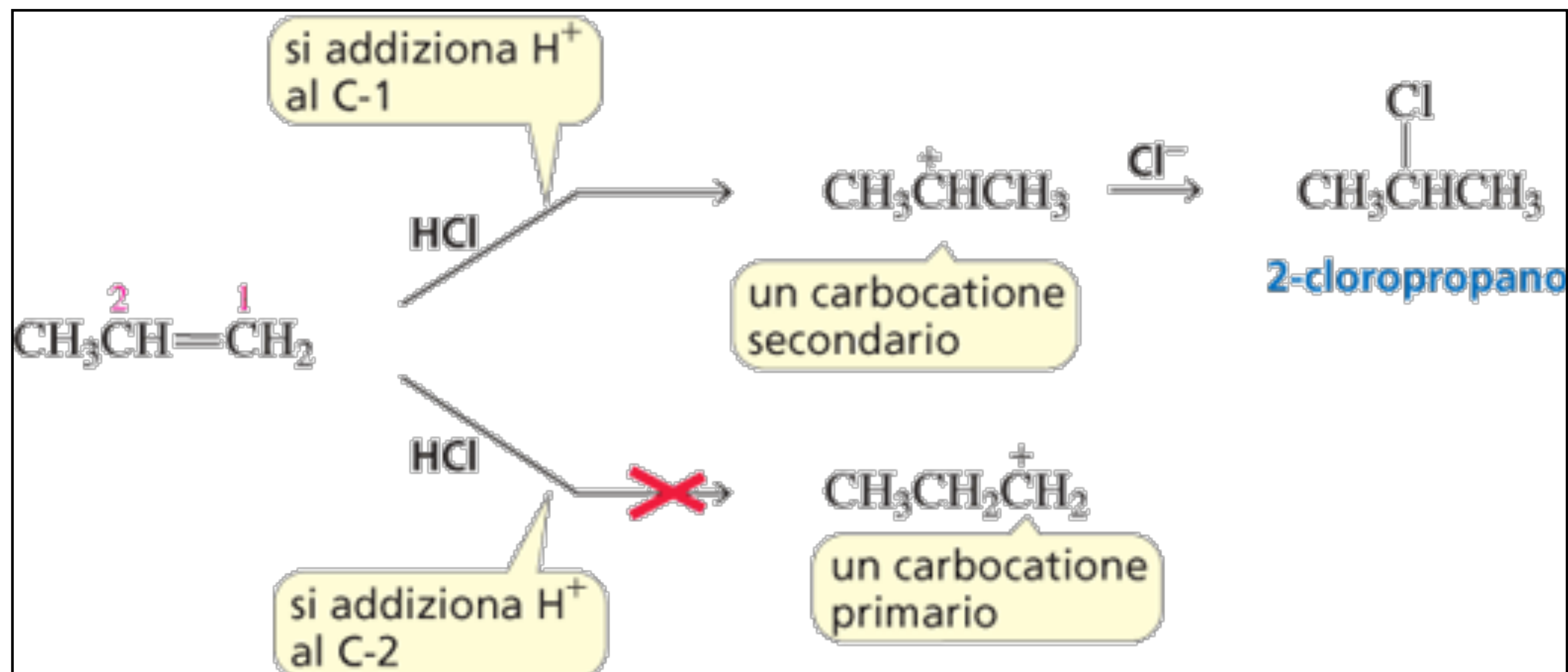


Diagramma energetico per la formazione di carbocationi

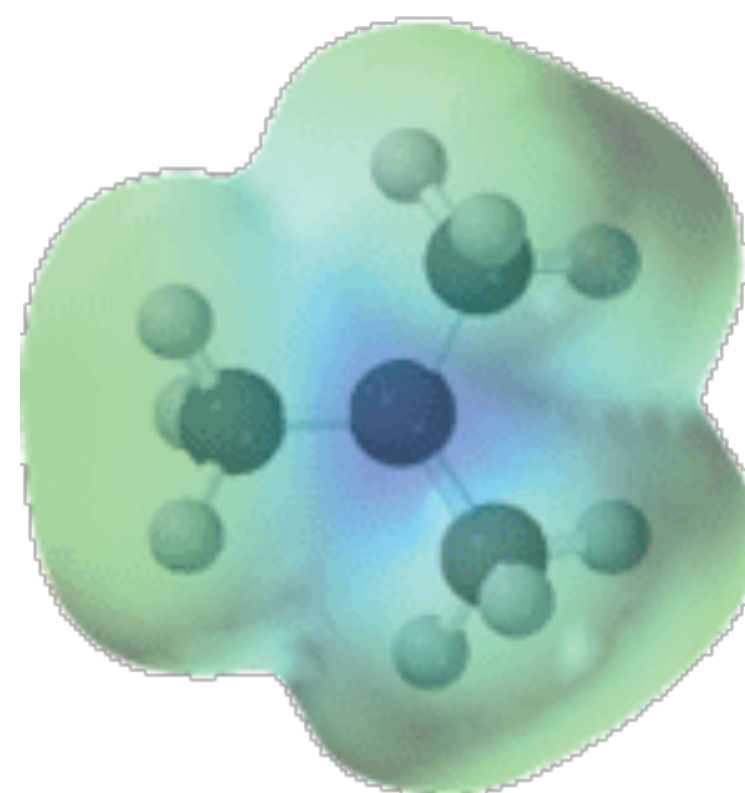
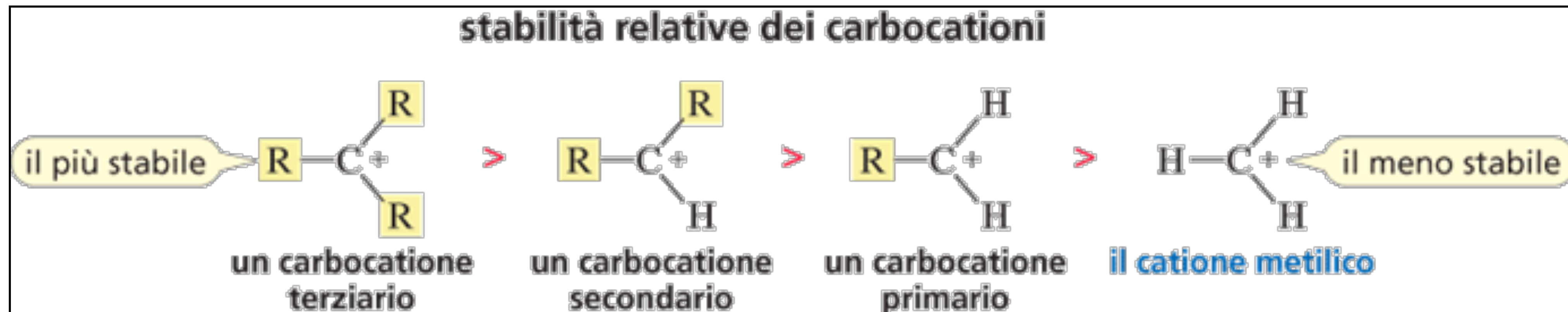




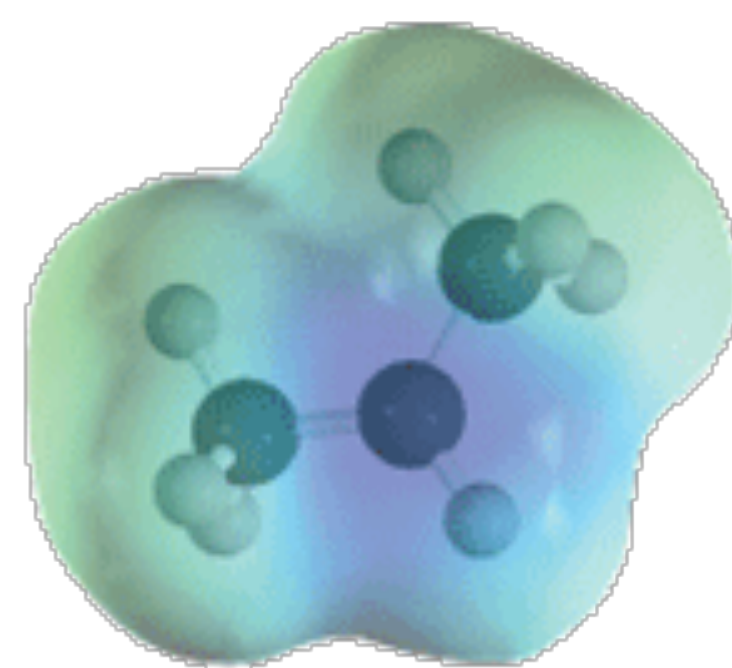
REGIOSELETTIVITÀ DELLE REAZIONI DI ADDIZIONE ELETTROFILA



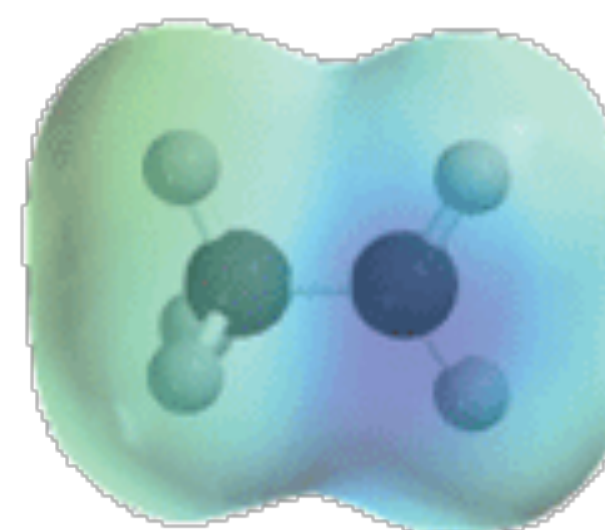
STABILITÀ DEI CARBOCATIONI



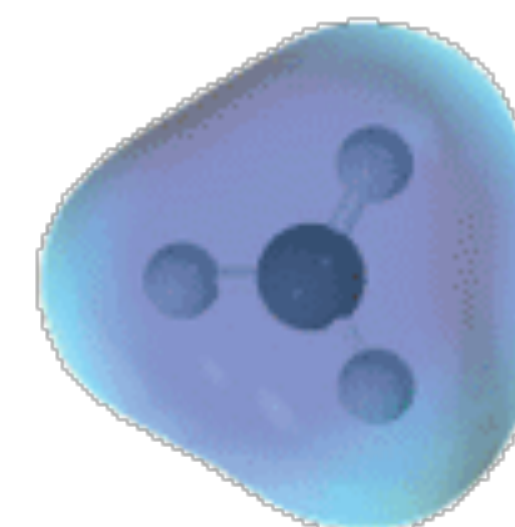
catione *terz*-butilico



catione isopropilico



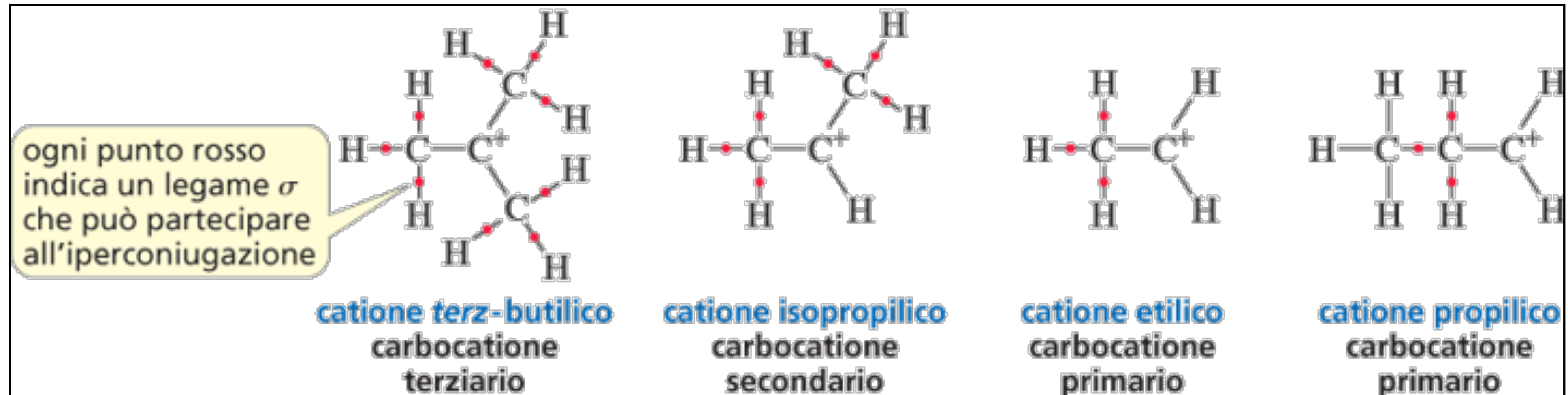
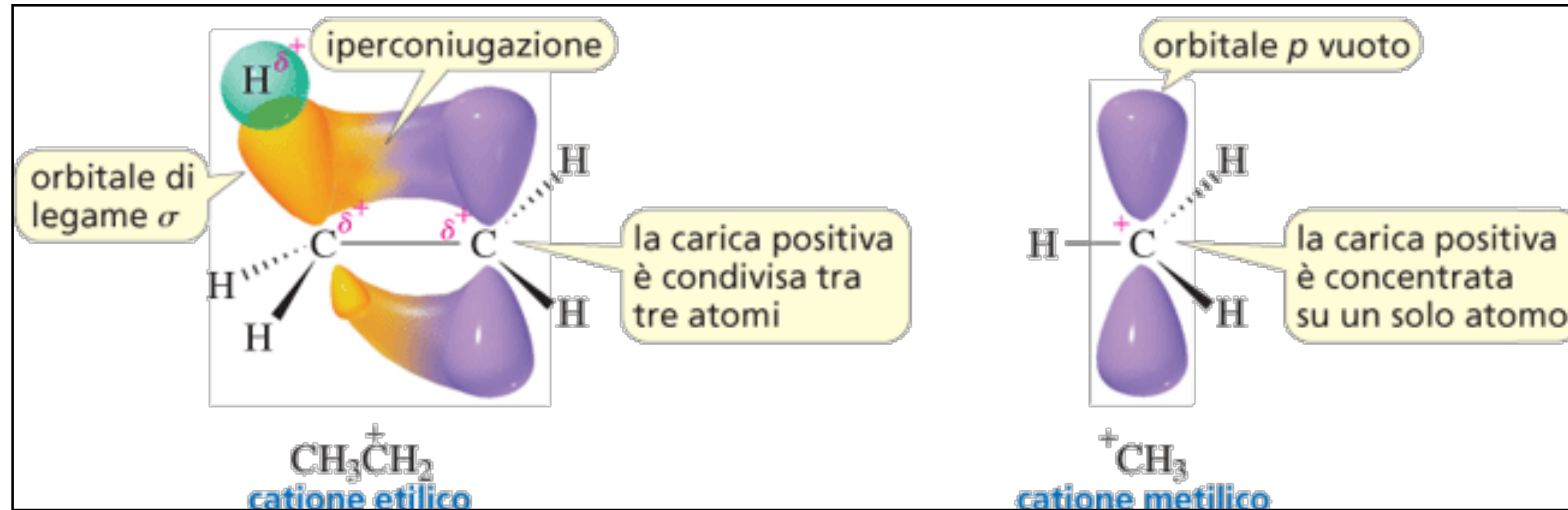
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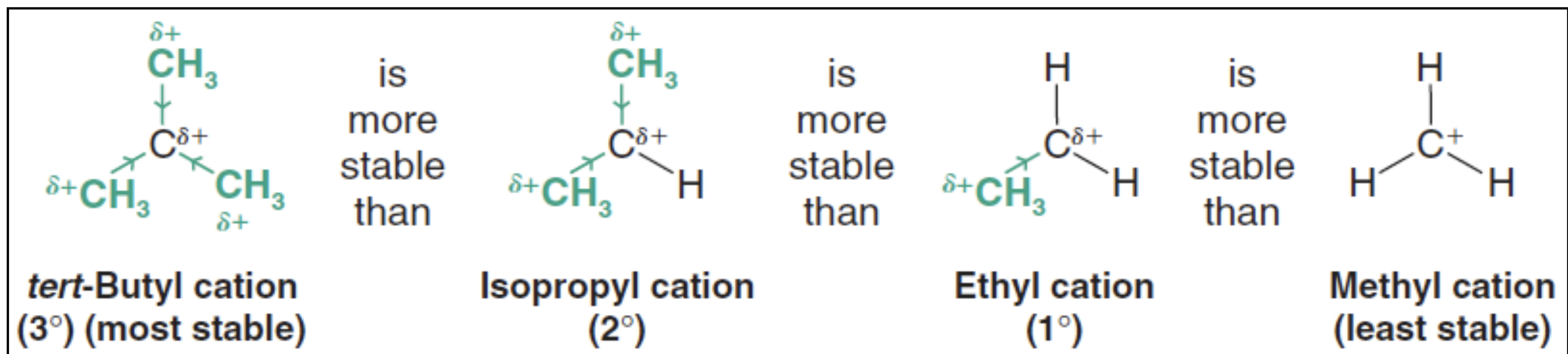
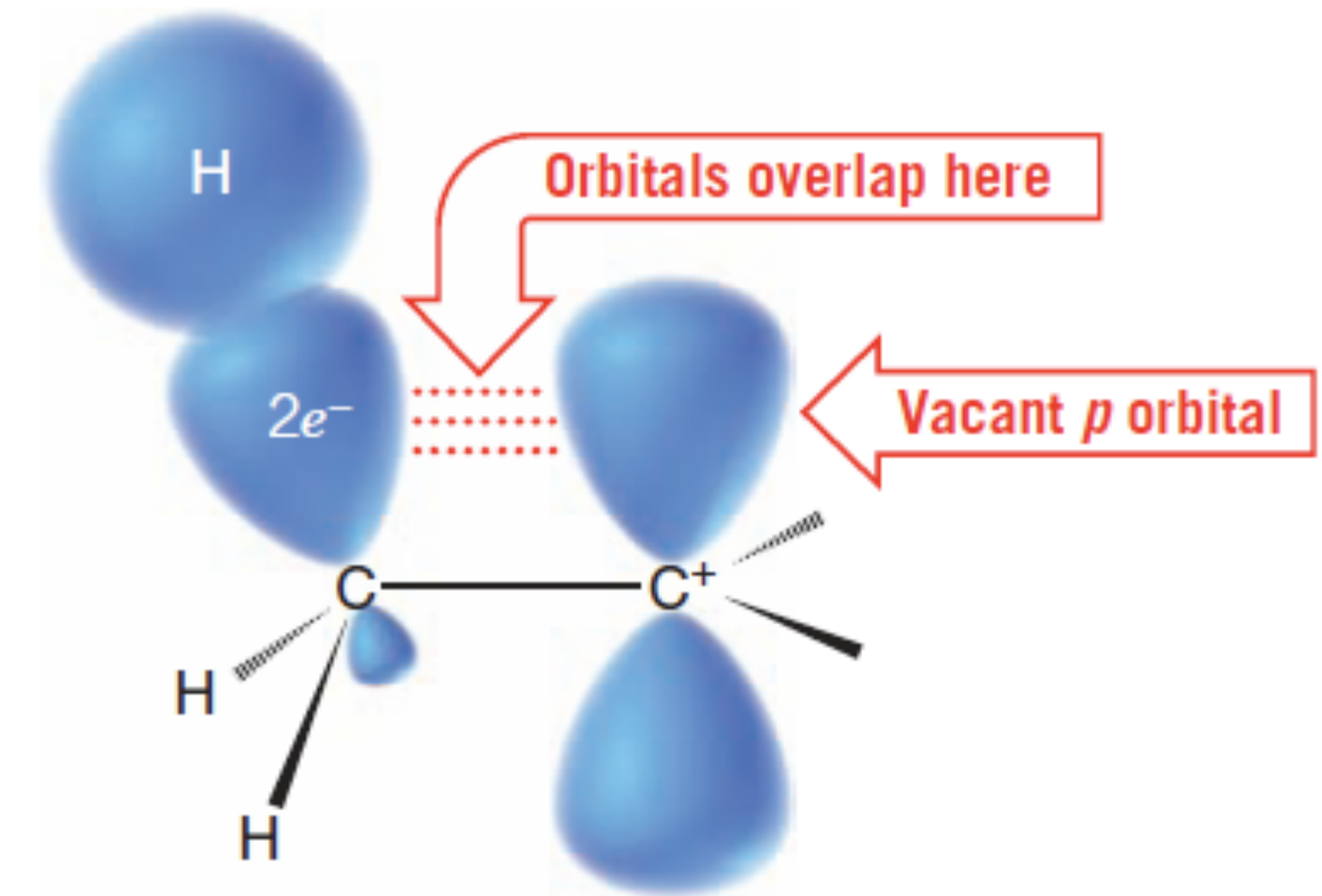
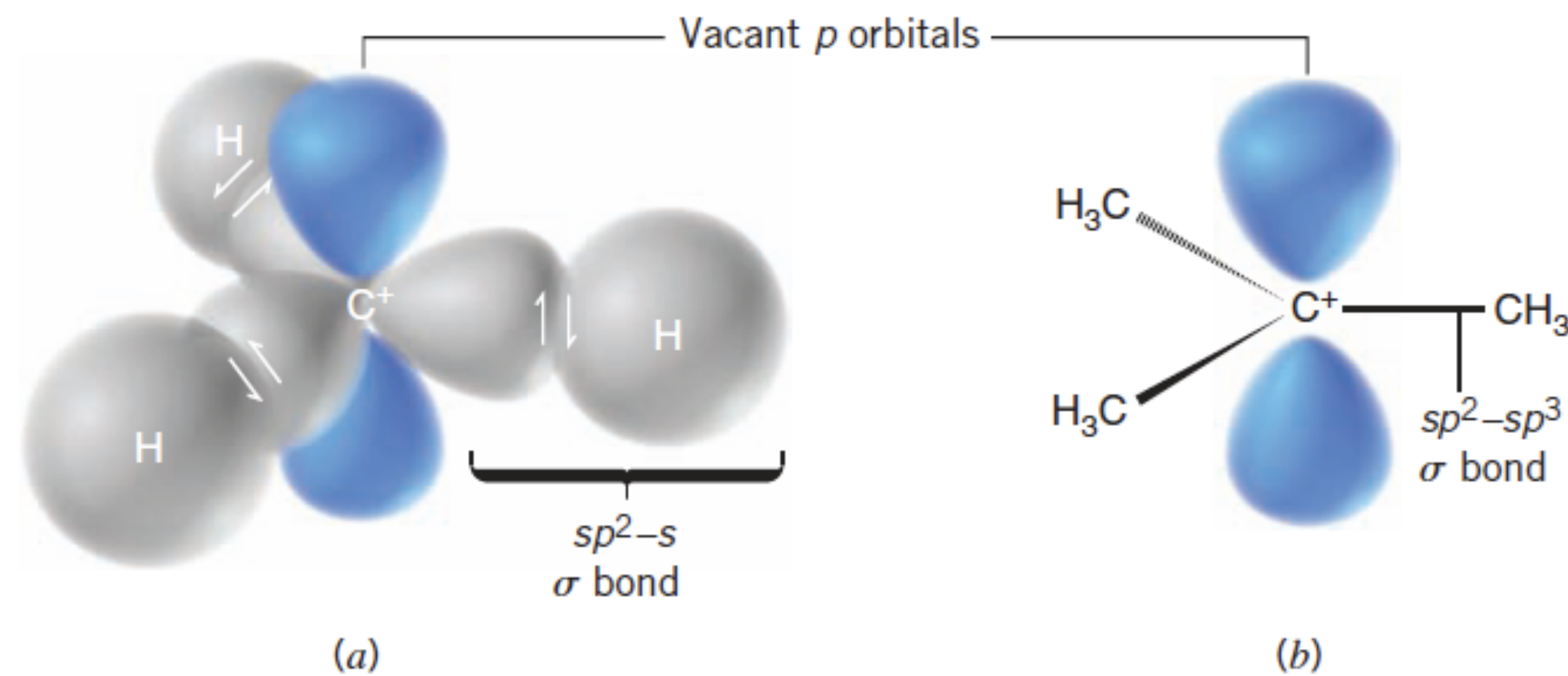
catione metilico

la colorazione blu più intensa indica il carbonio con la più alta densità di carica positiva

STABILITÀ DEI CARBOCATIONI: IPERCONIUGAZIONE



STABILITÀ DEI CARBOCATIONI: IPERCONIUGAZIONE



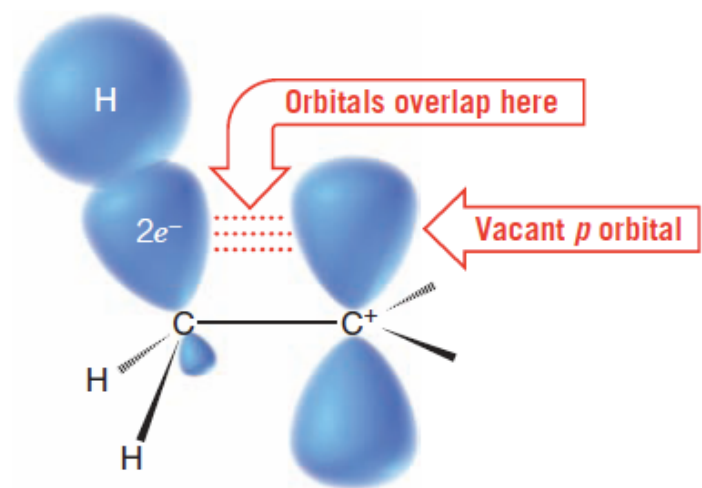
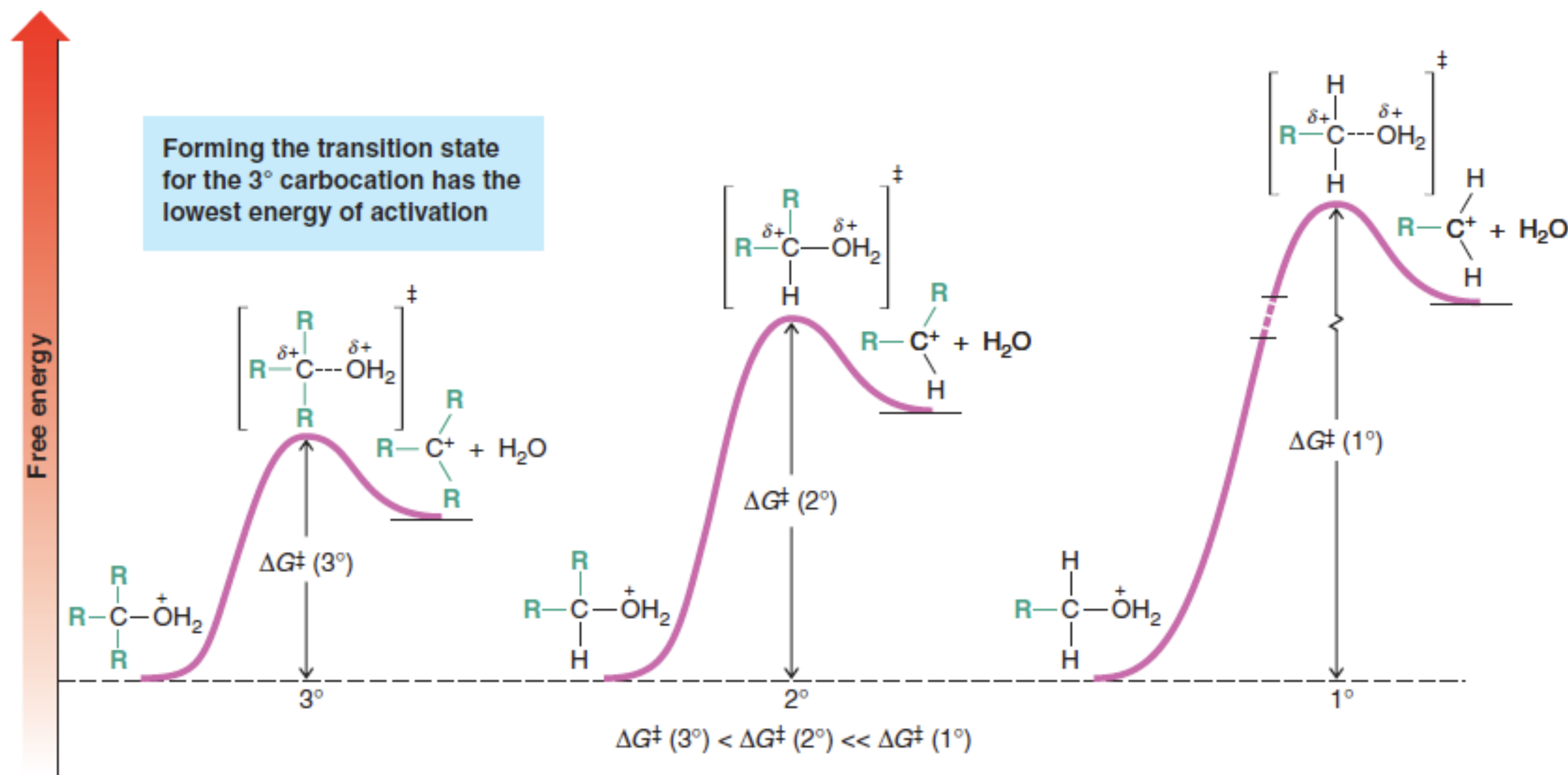


Diagramma di energia libera Per la formazione dei carbocationi a partire Dagli alcoli protonati.



Stereochimica delle reazioni di addizione all'alcheno

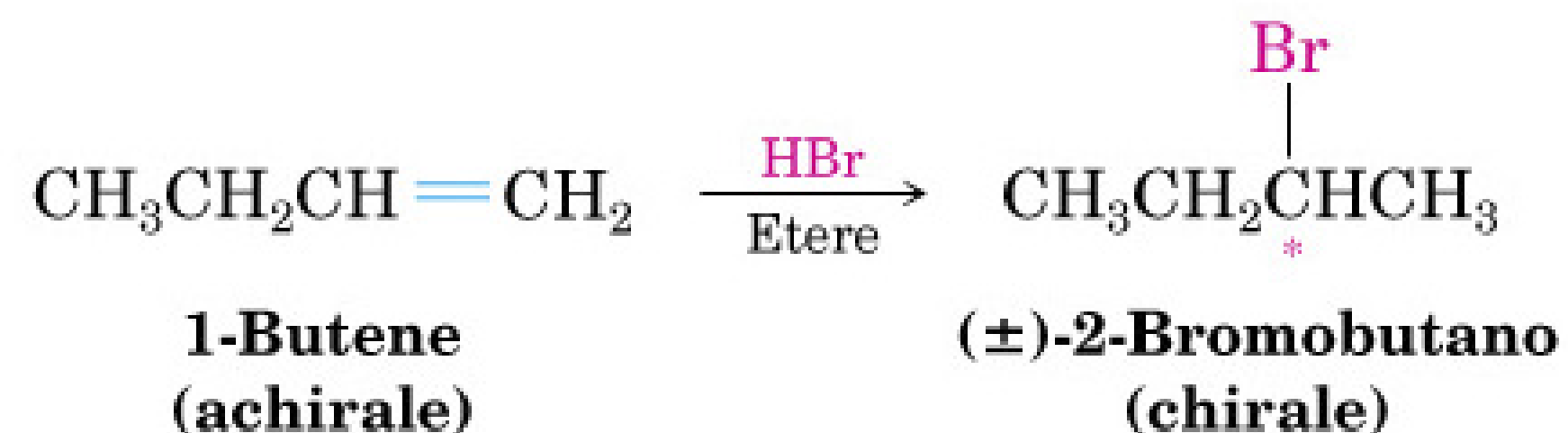
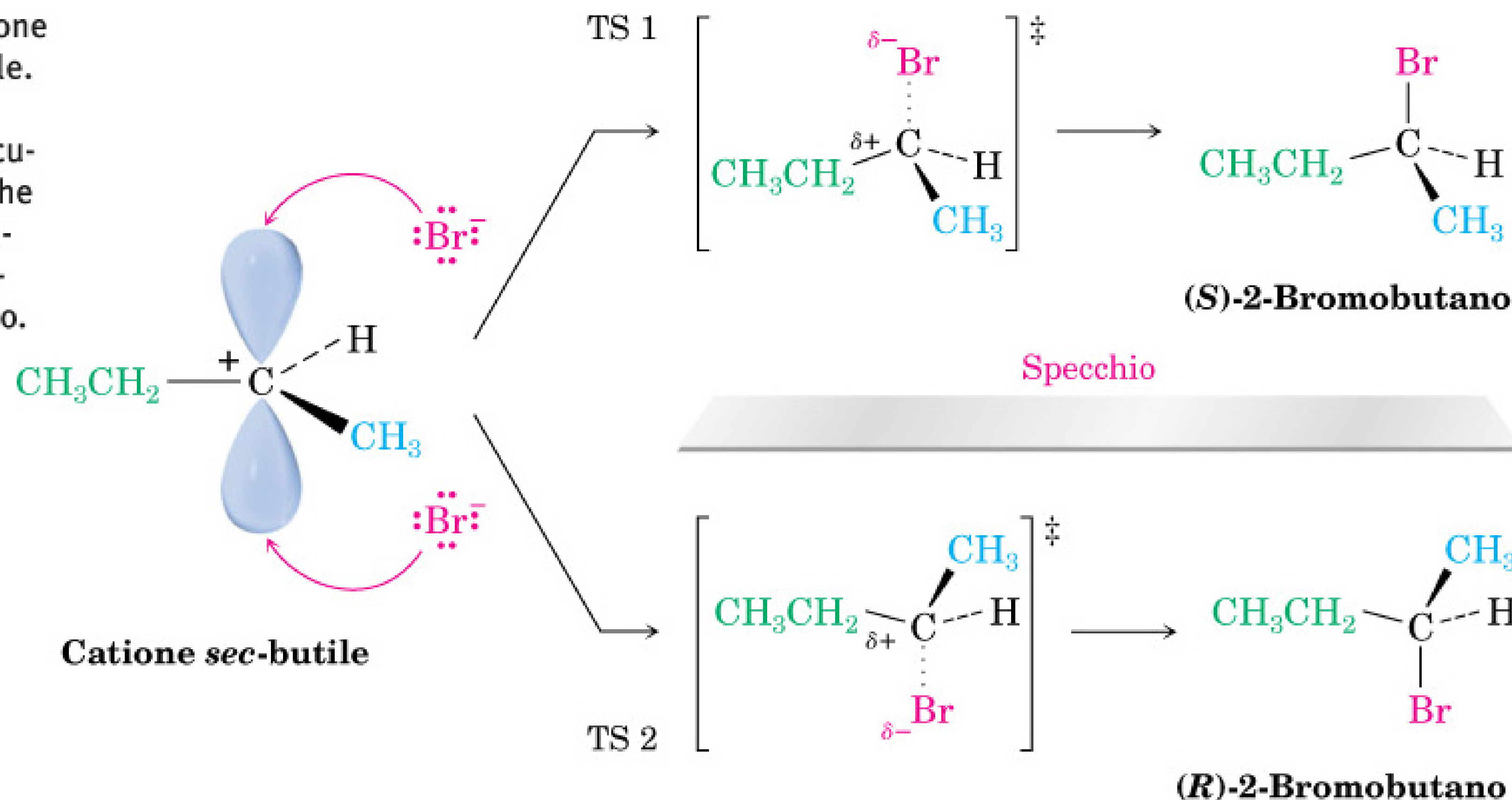
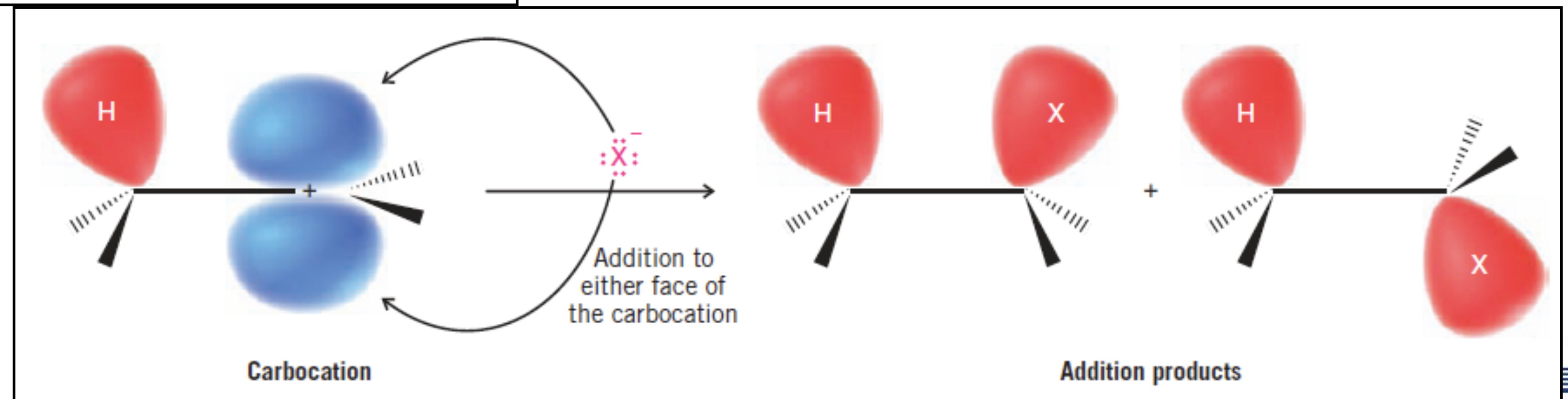
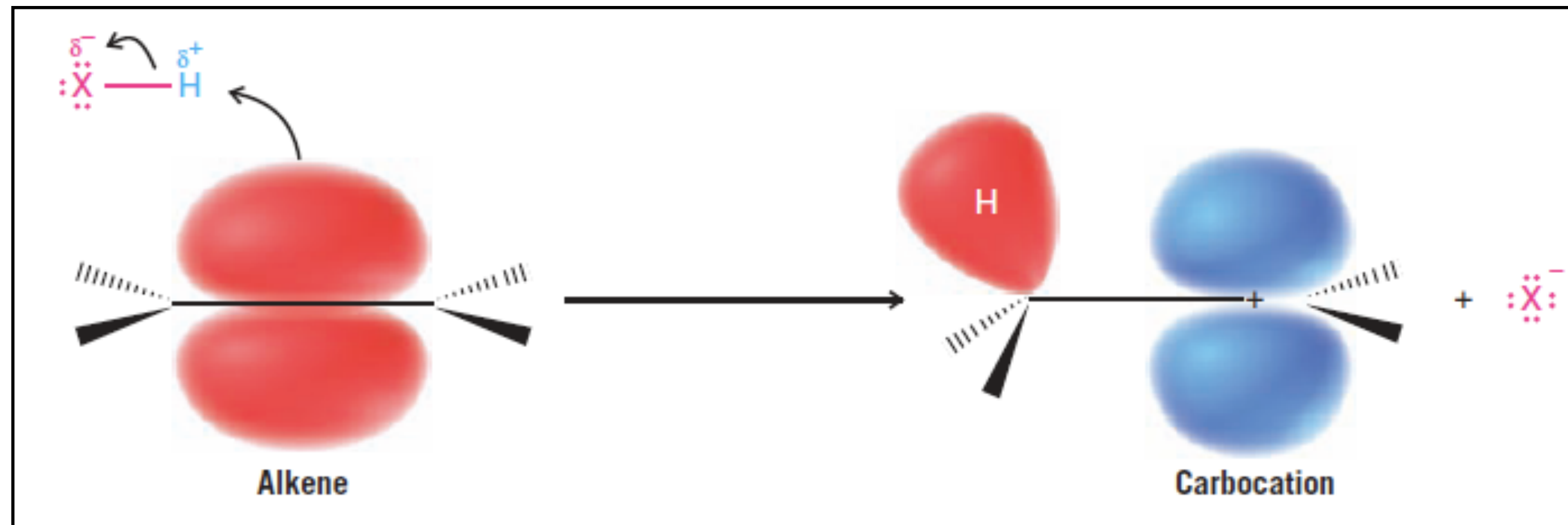
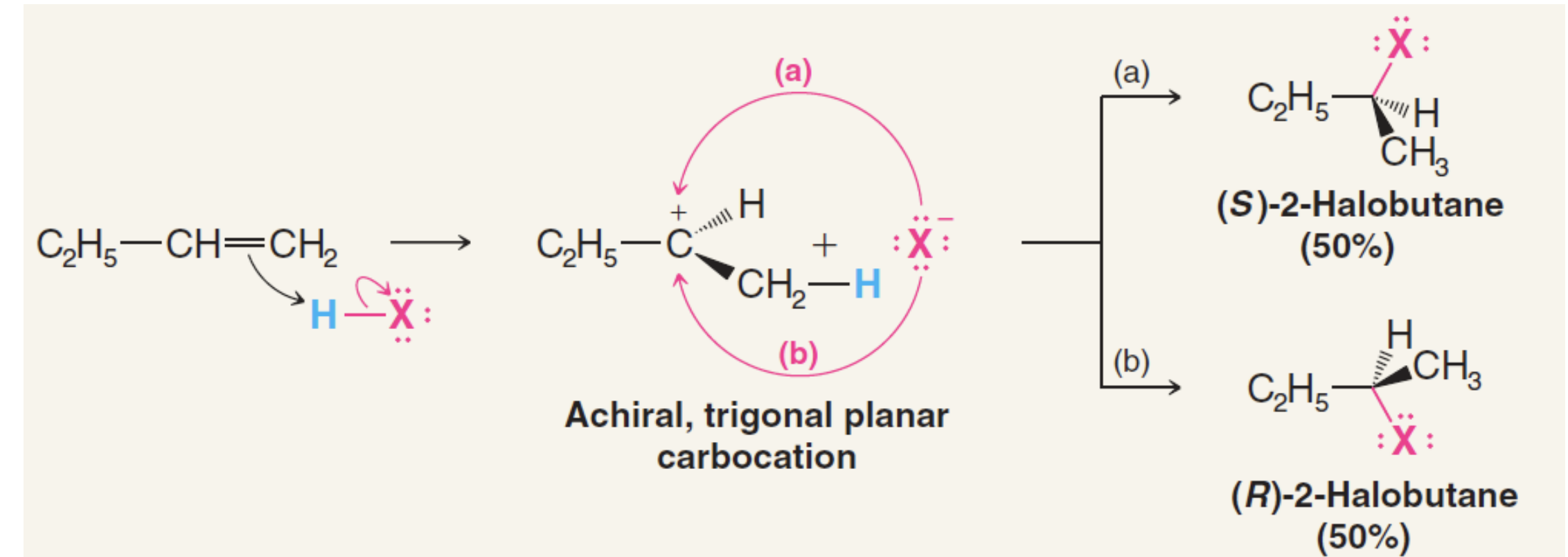


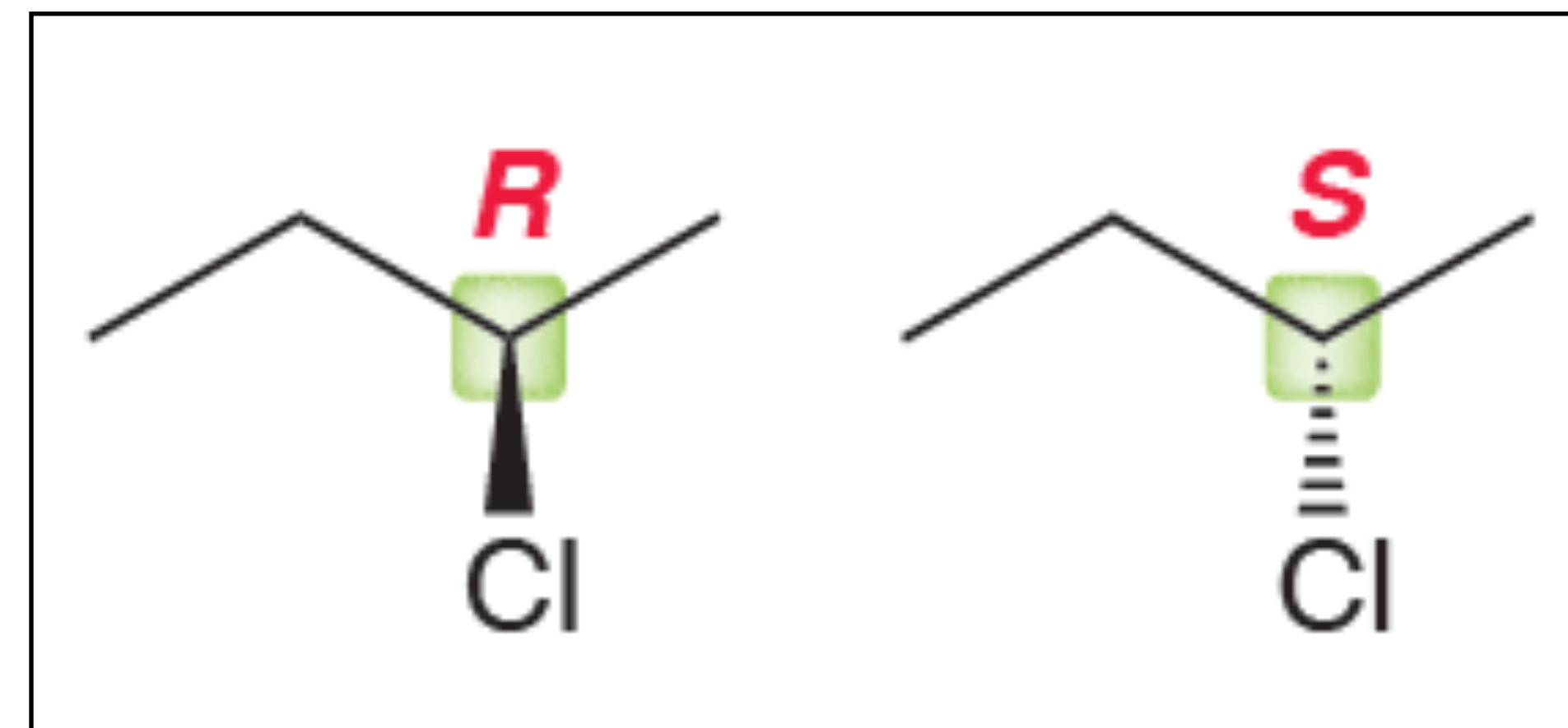
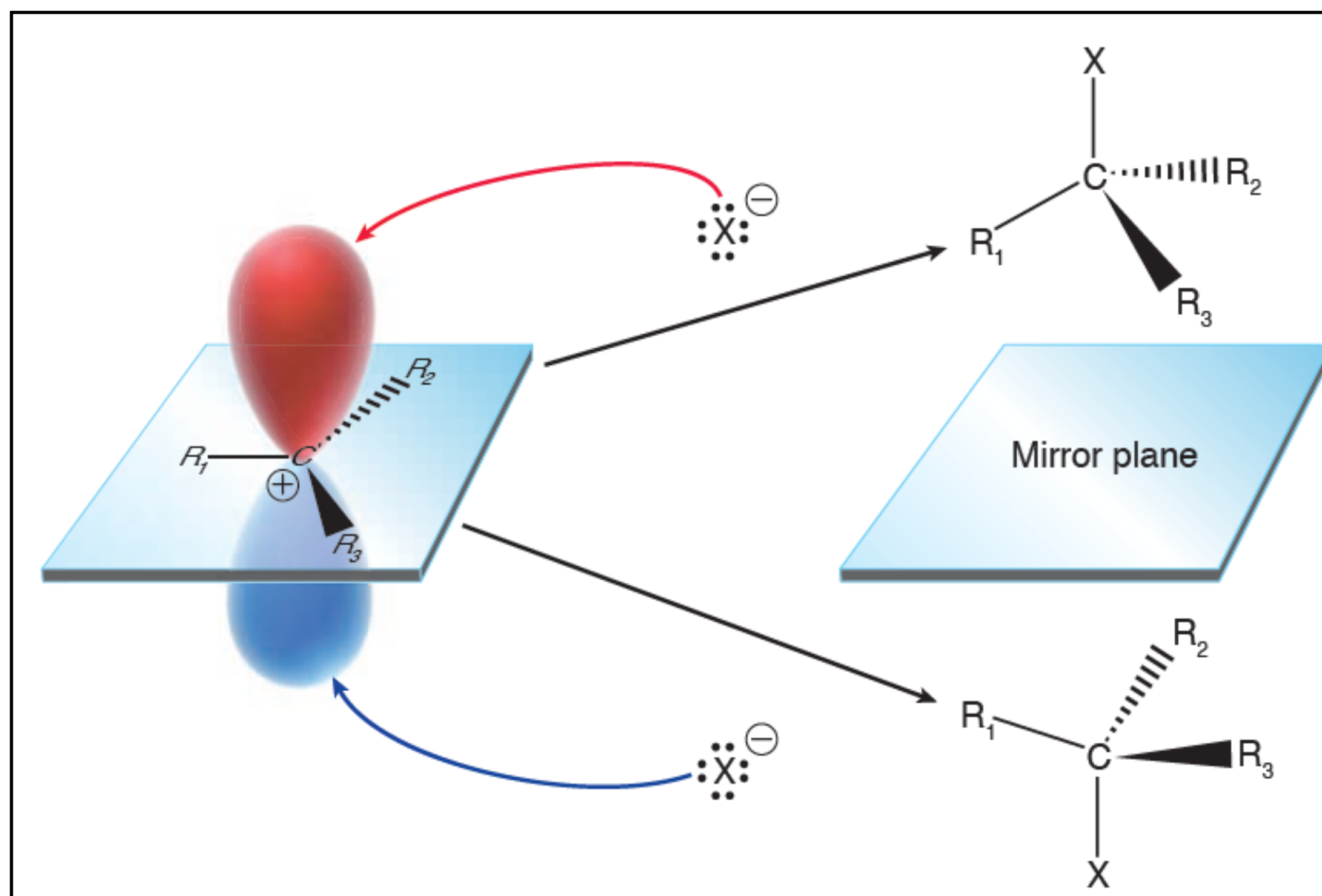
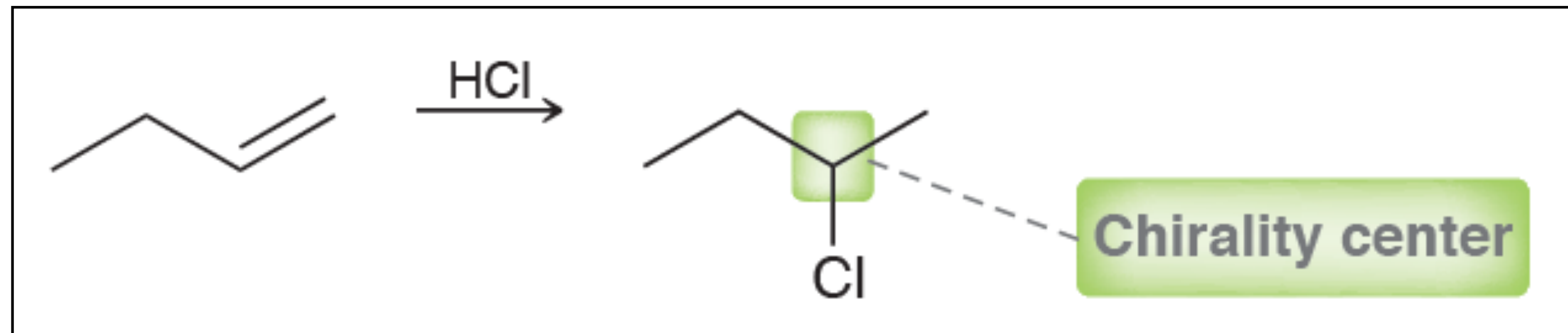
FIGURA 9.15 Reazione dello ione Br^- con il carbocatione *sec*-butile. La reazione “da sopra” porta al prodotto *S* ed è l’immagine speculare della reazione “da sotto”, che porta al prodotto *R*. Dato che entrambe sono ugualmente probabili, si forma il prodotto racemico. Nello stato di transizione il legame $\text{C}\cdots\text{Br}$ punteggiato indica la parziale formazione del legame.



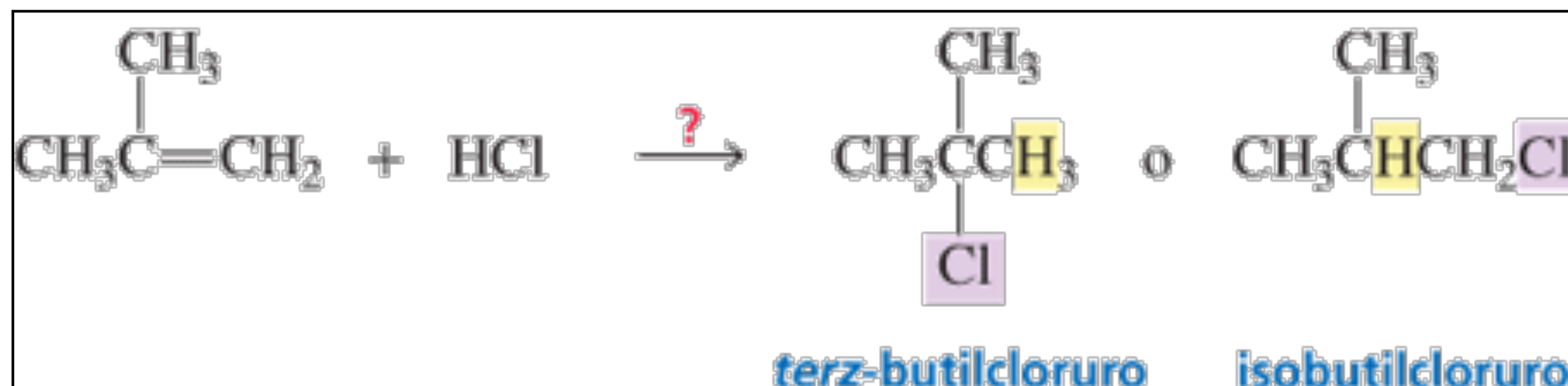
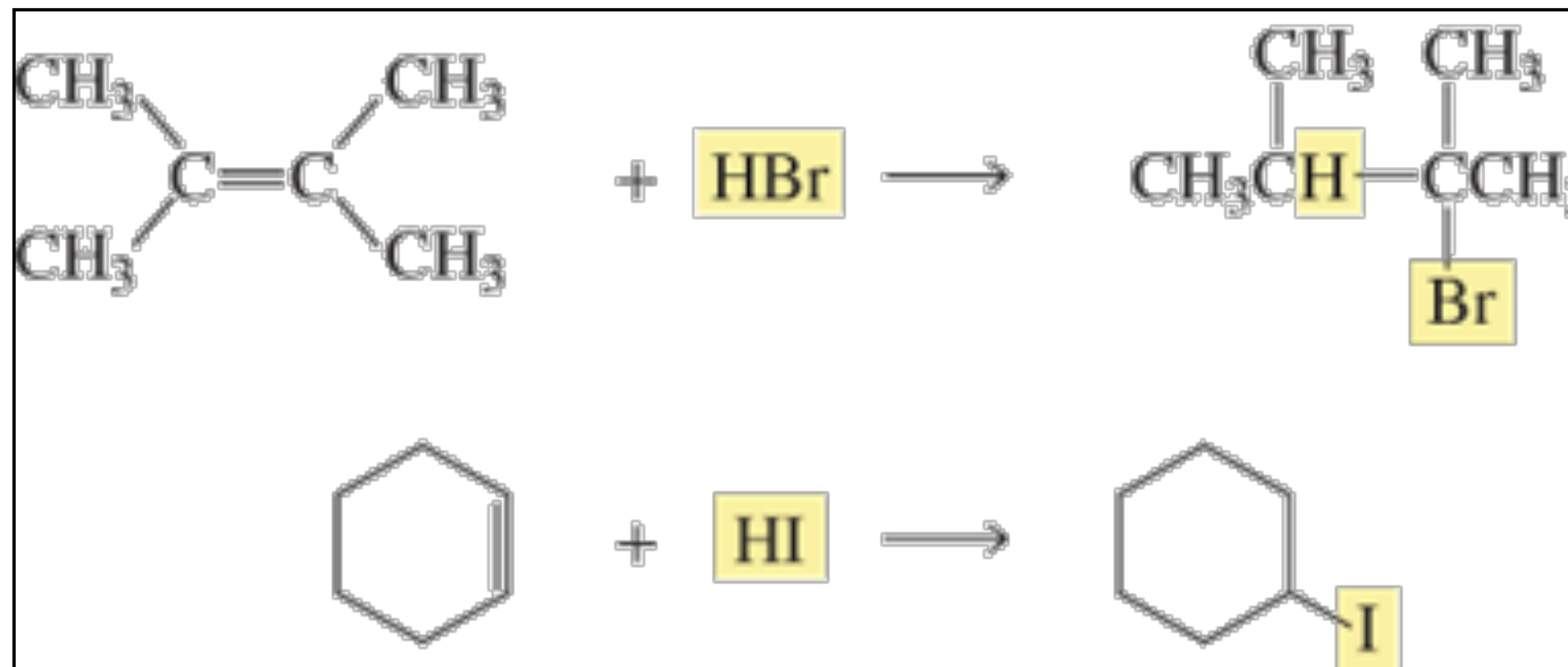
Stereochimica delle reazioni di addizione all'alcheno



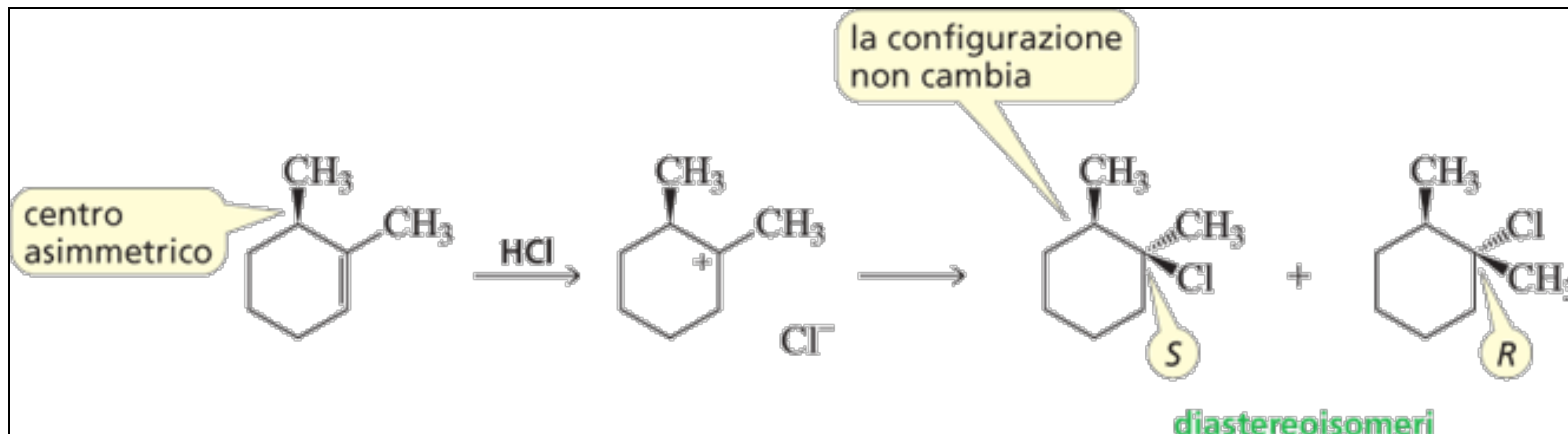
Stereochimica delle reazioni di addizione all'alcheno



ADDIZIONE DI ACIDO ALOGENIDRICO AGLI ALCENI

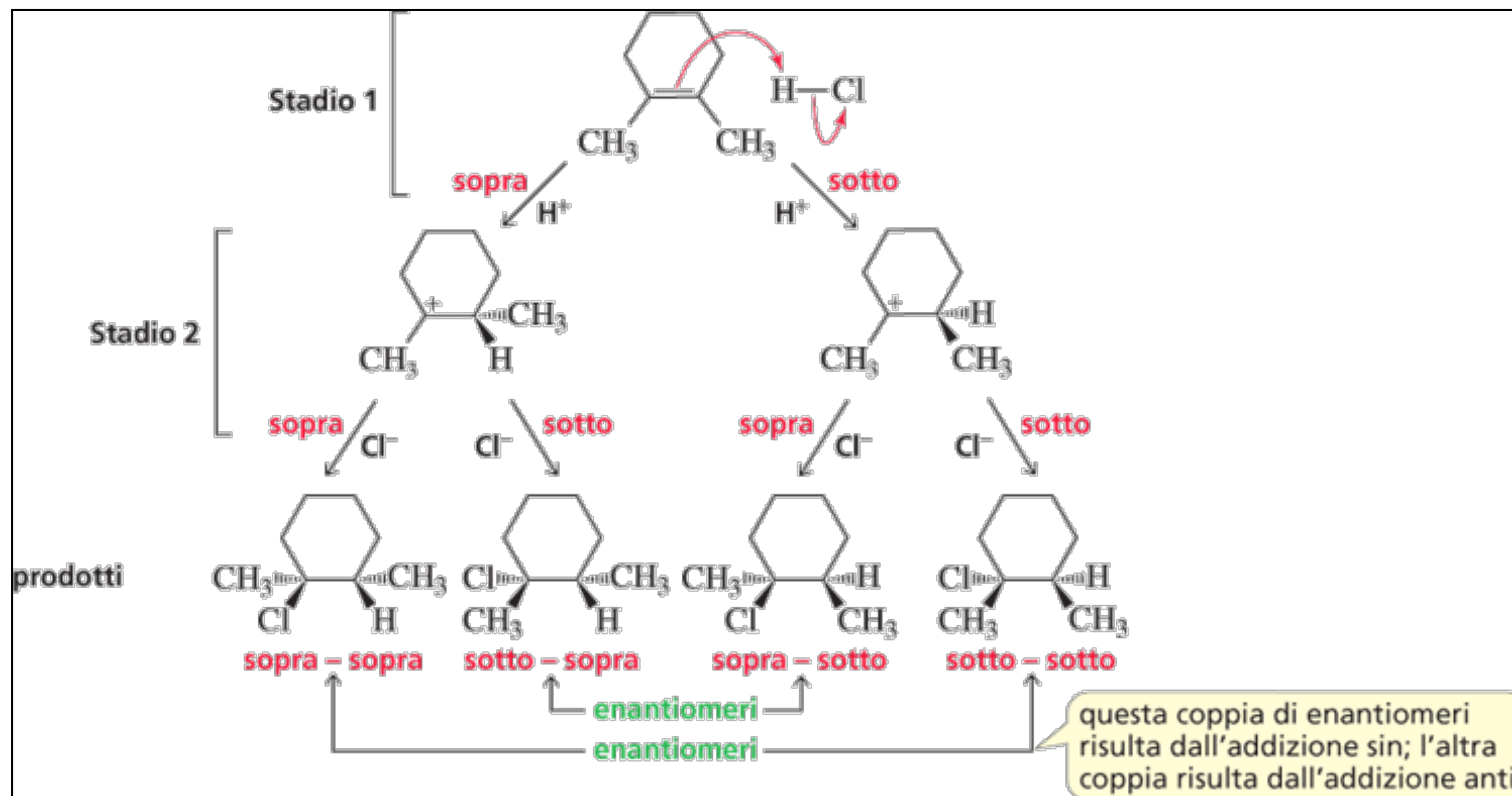
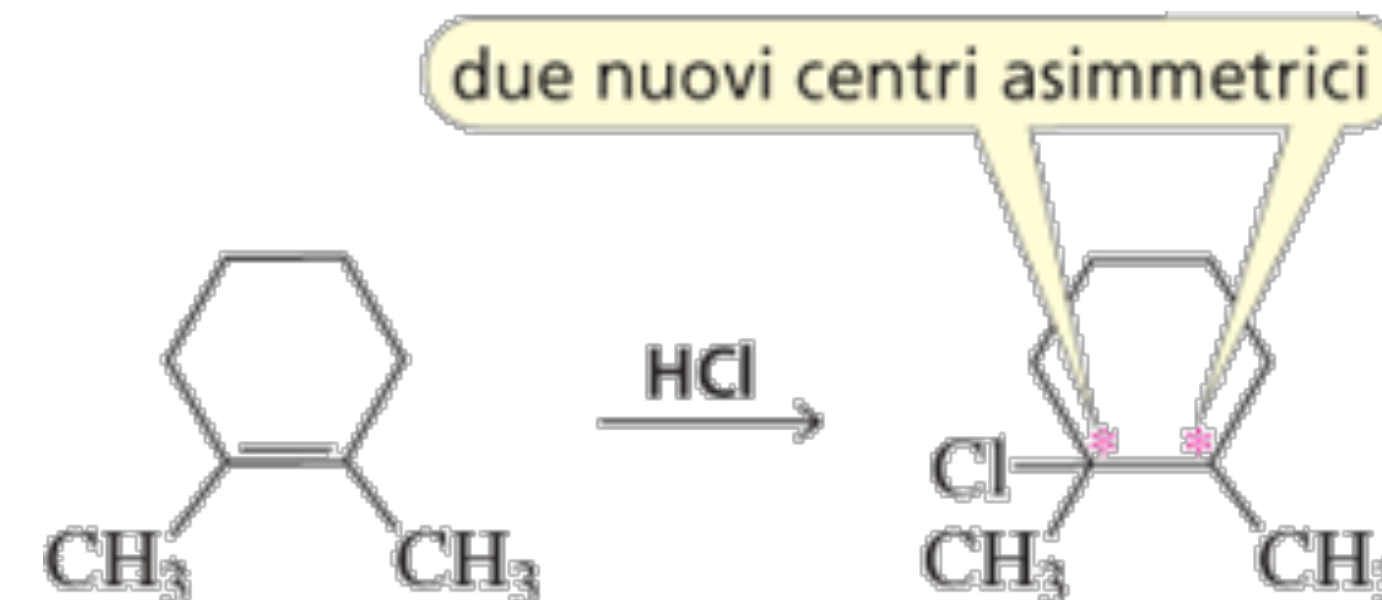


Stereochimica delle reazioni di addizione all'alcheno Con formazione di due nuovi centri asimmetrici



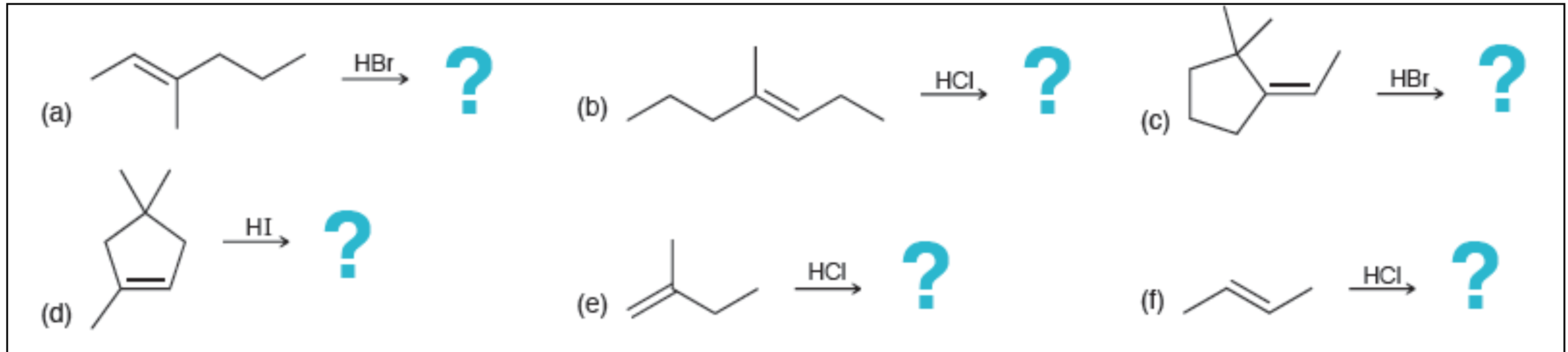
Stereochimica delle reazioni di addizione all'alcheno

Con formazione di due nuovi centri asimmetrici

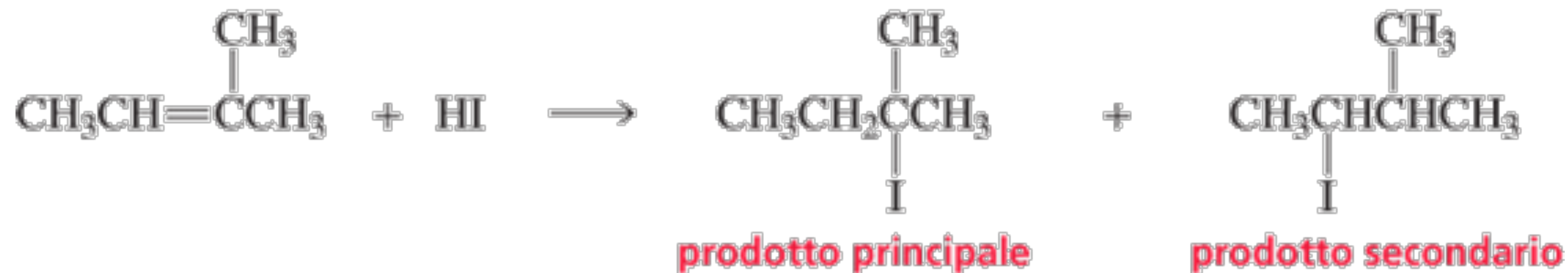


ADDIZIONE DI ACIDO ALOGENIDRICO AGLI ALCENI

REGIOSELETTIVITÀ DELLE REAZIONI DI ADDIZIONE ELETTROFILA



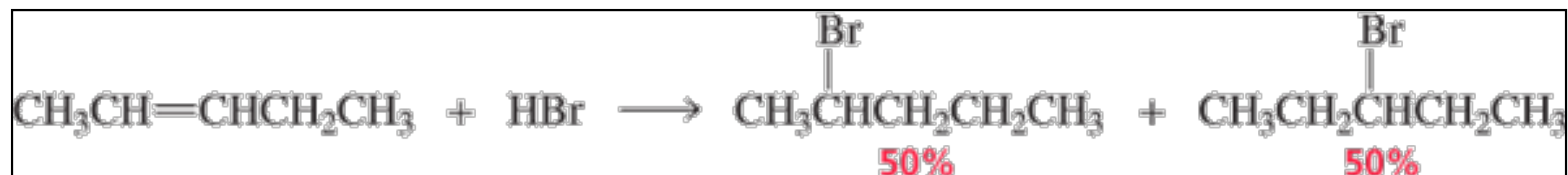
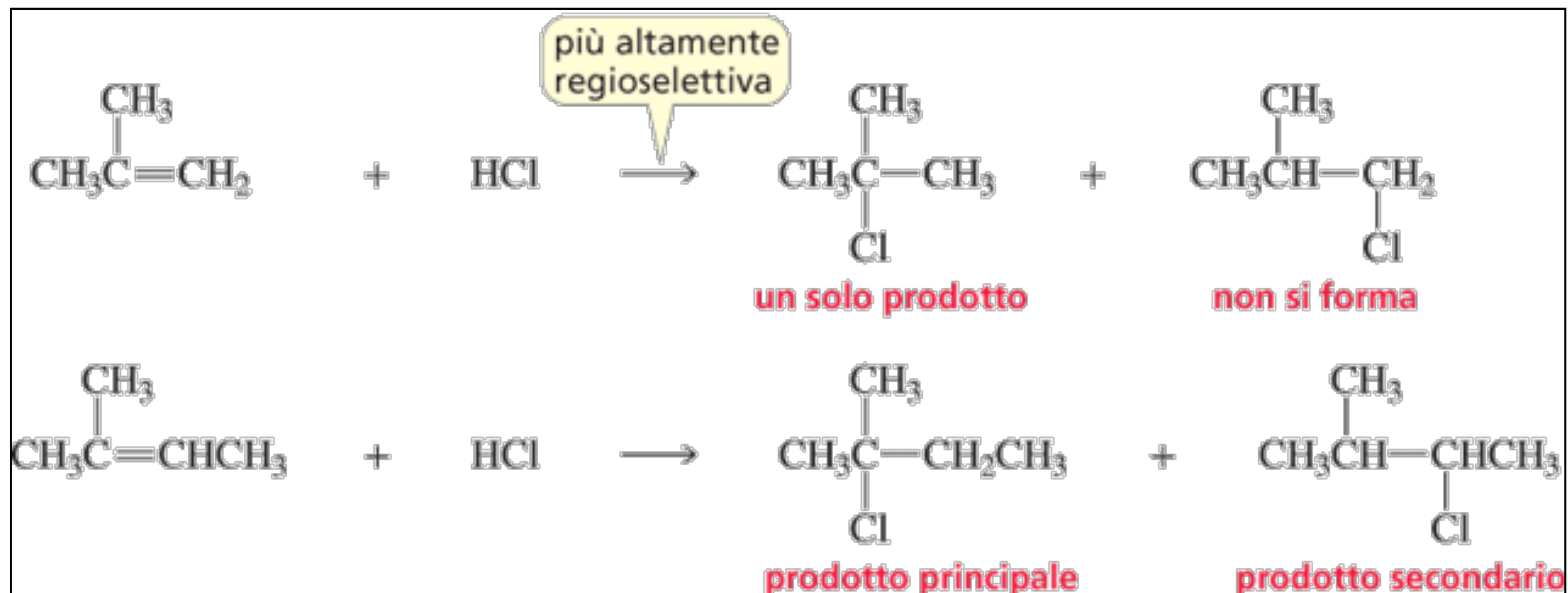
REGIOSELETTIVITÀ DELLE REAZIONI DI ADDIZIONE ELETTROFILA



I due prodotti che si formano in ciascuna delle reazioni precedenti vengono definiti isomeri costituzionali. Una reazione da cui si potrebbero ottenere due o più isomeri costituzionali, ma uno è formato in maniera predominante, viene definita reazione regioselettiva.

Gradi di regioselettività

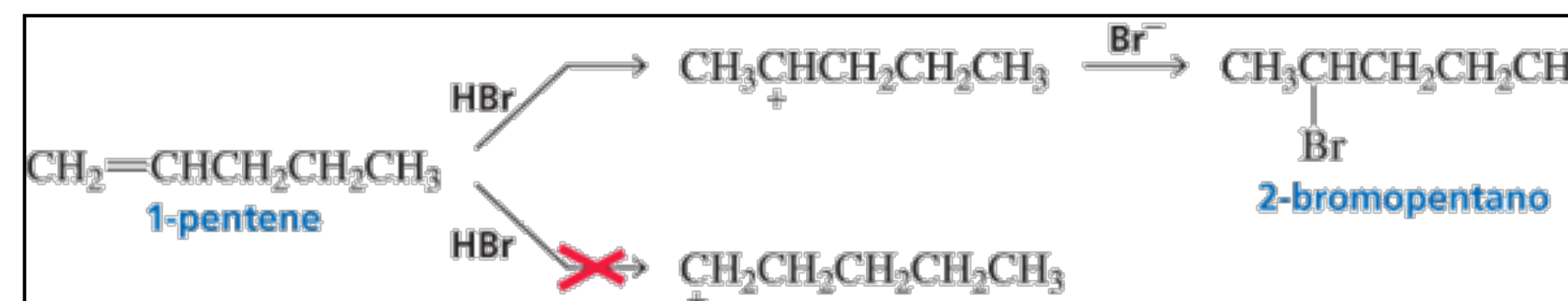
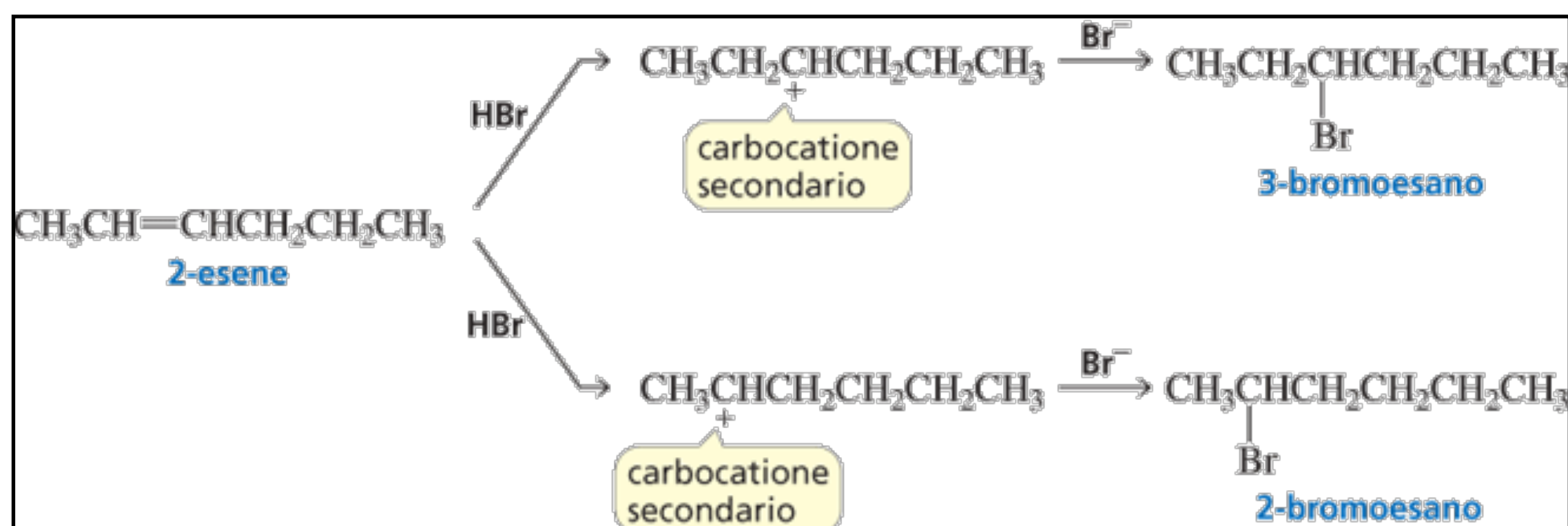
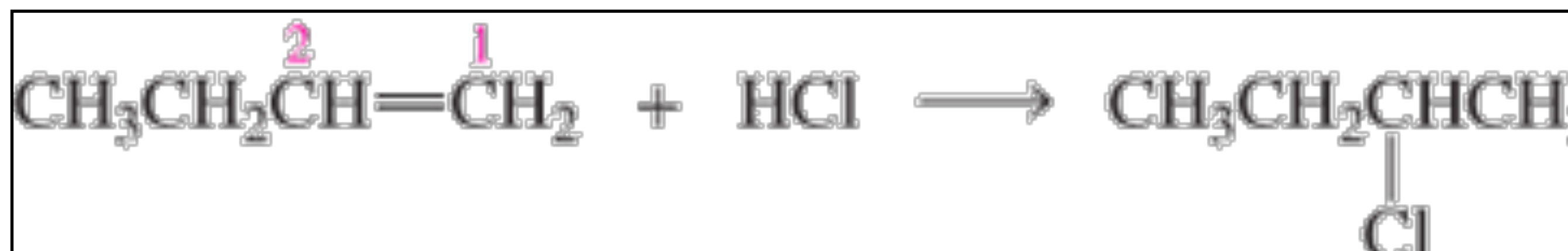
Ci sono diversi gradi di regioselettività: una reazione può essere moderatamente regioselettiva, altamente regioselettiva o totalmente regioselettiva.



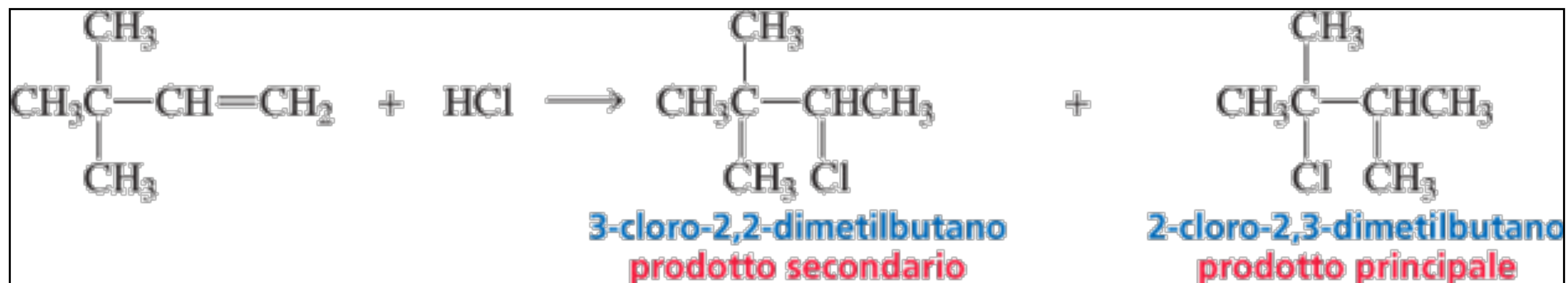
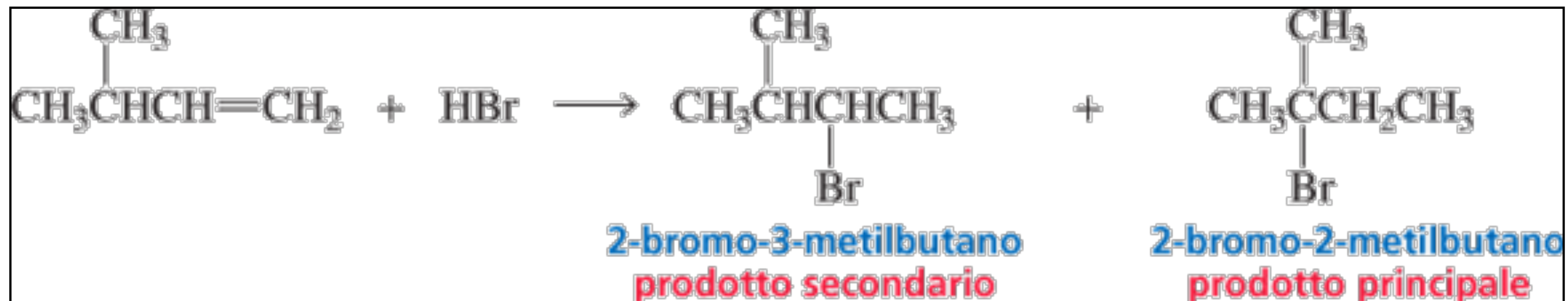
La regola che determina il prodotto di una reazione di addizione elettrofila

Regola di Vladimir Markonikov

L'elettrofilo si addiziona preferenzialmente al carbonio sp² che lega il maggior numero di idrogeni.



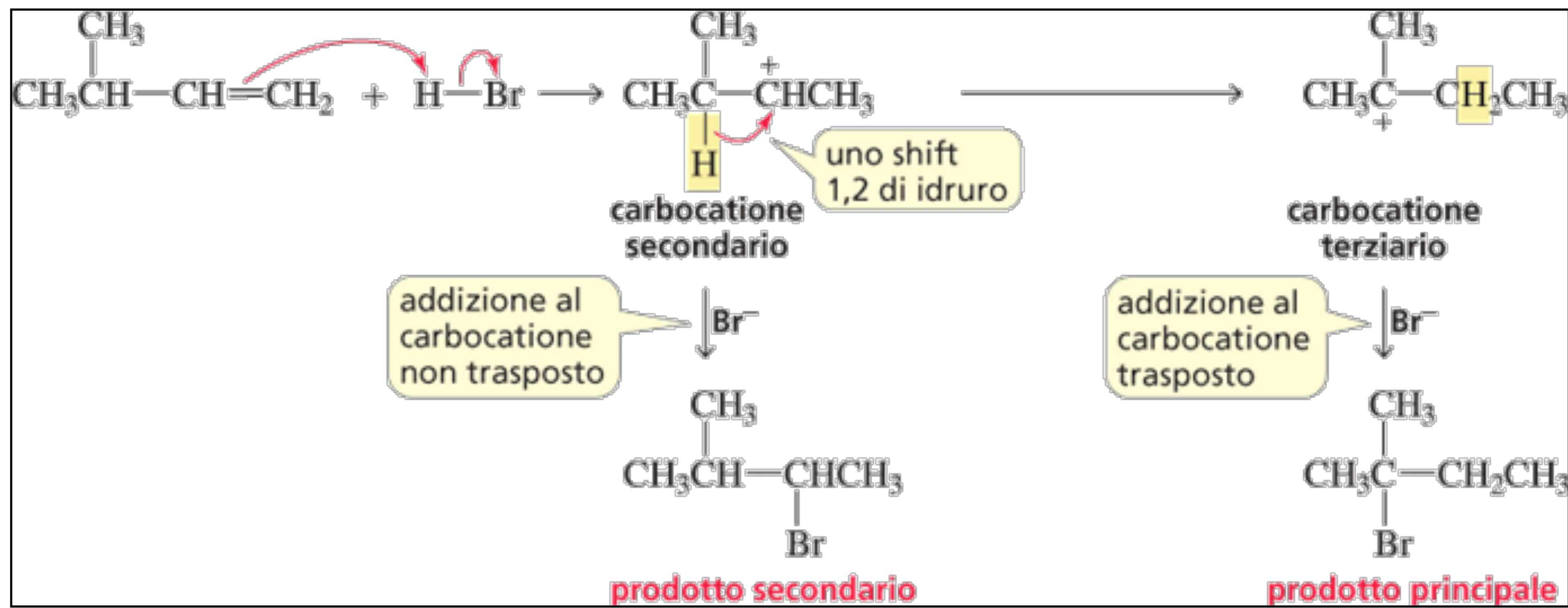
TRASPOSIZIONE DEI CARBOCATIONI

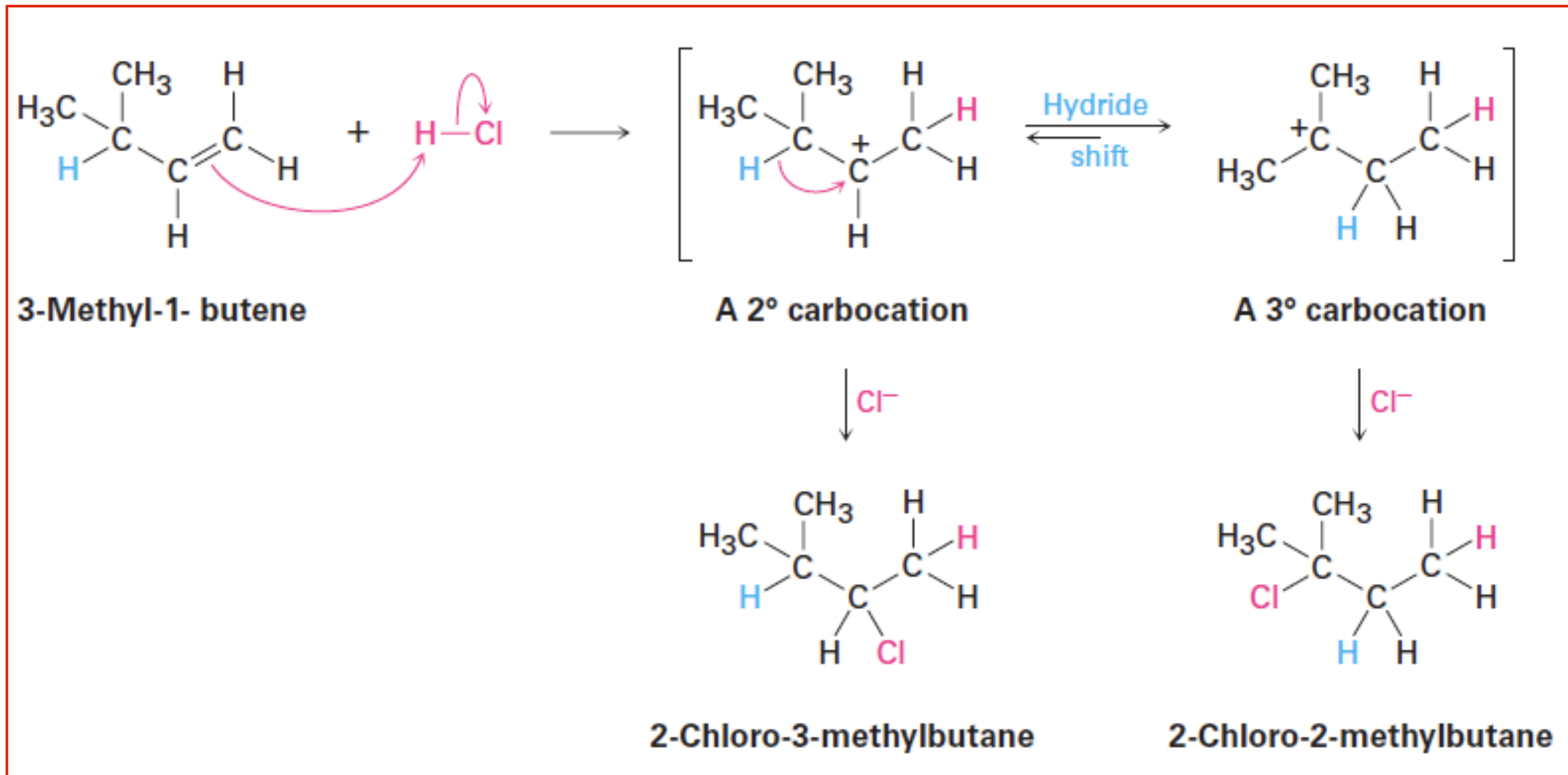


In ciascuna reazione il prodotto inatteso è il risultato di una trasposizione (o riarrangiamento) del carbocatione intermedio. Non tutti i carbocationi danno trasposizione.

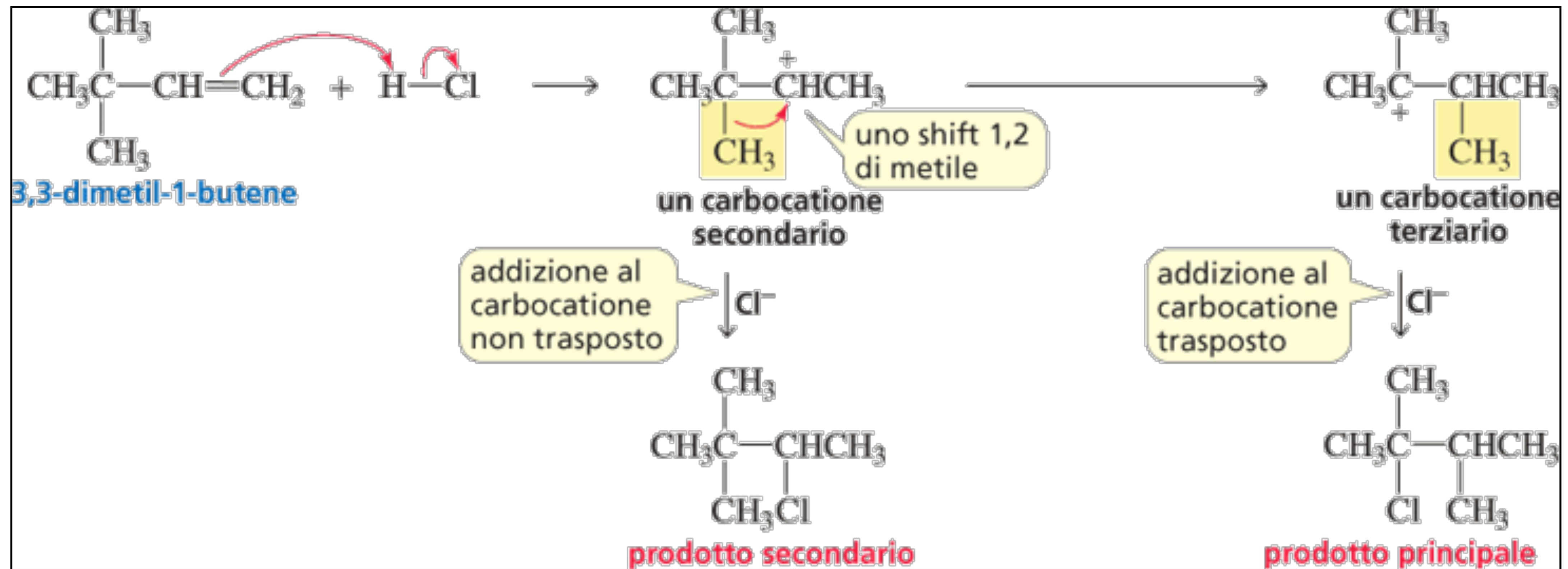
La trasposizione dei carbocationi avviene solo se porta alla formazione di carbocationi più stabili.

TRASPOSIZIONE DEI CARBOCATIONI: Shift 1,2 di idruro

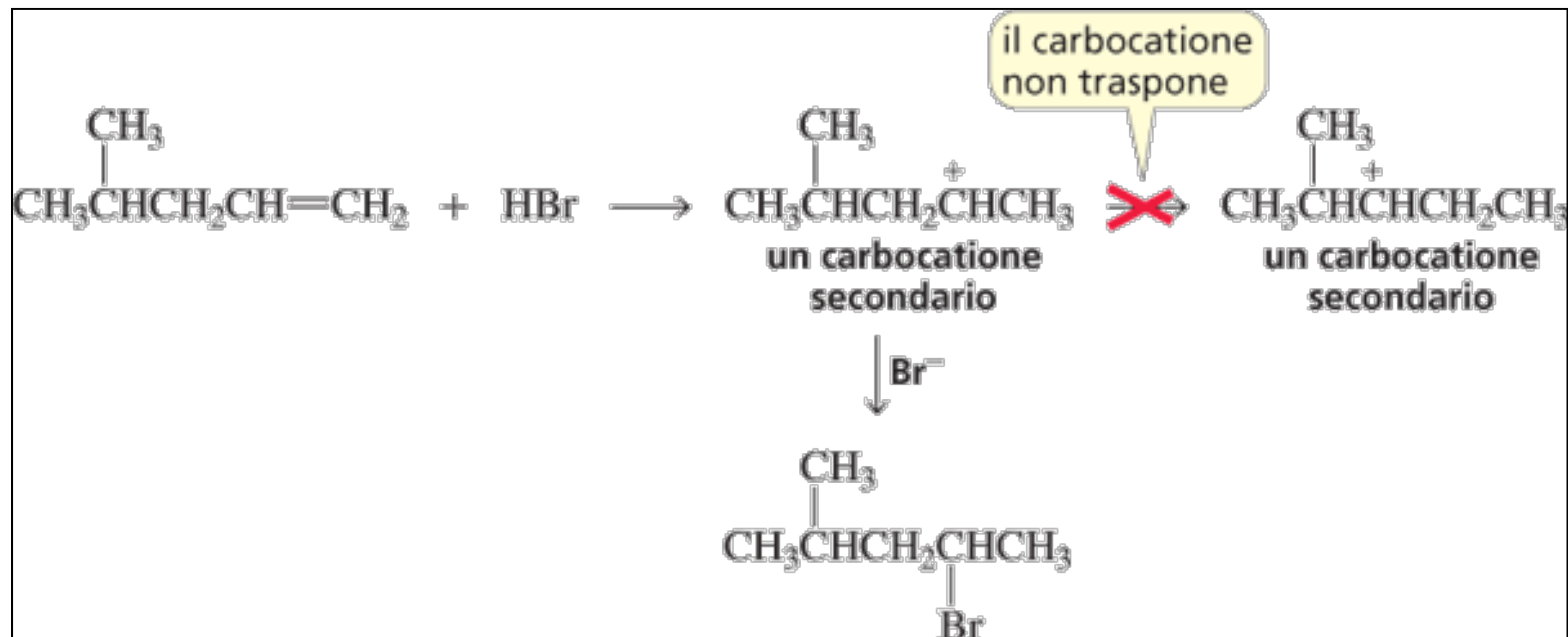




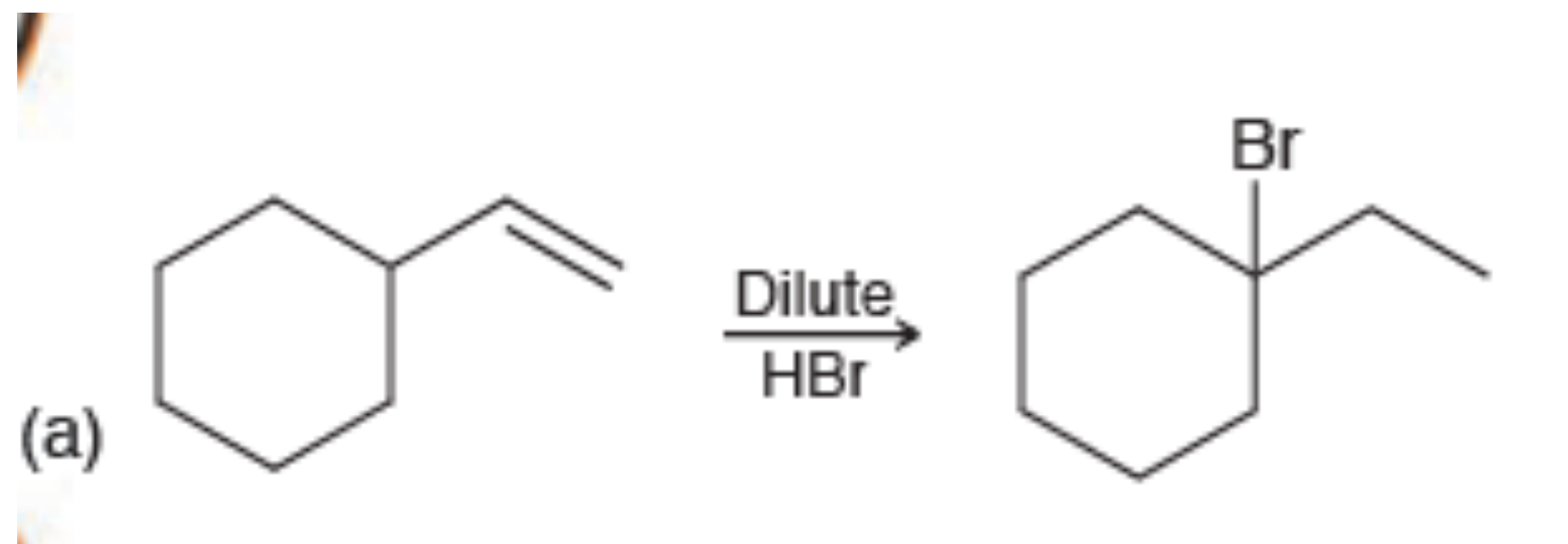
TRASPOSIZIONE DEI CARBOCATIONI; Shift 1,2 di metile ($:-\text{CH}_3$)



Ogni volta che una reazione forma un carbocatione intermedio, si deve considerare la possibilità di una sua trasposizione a un carbocatione più stabile.

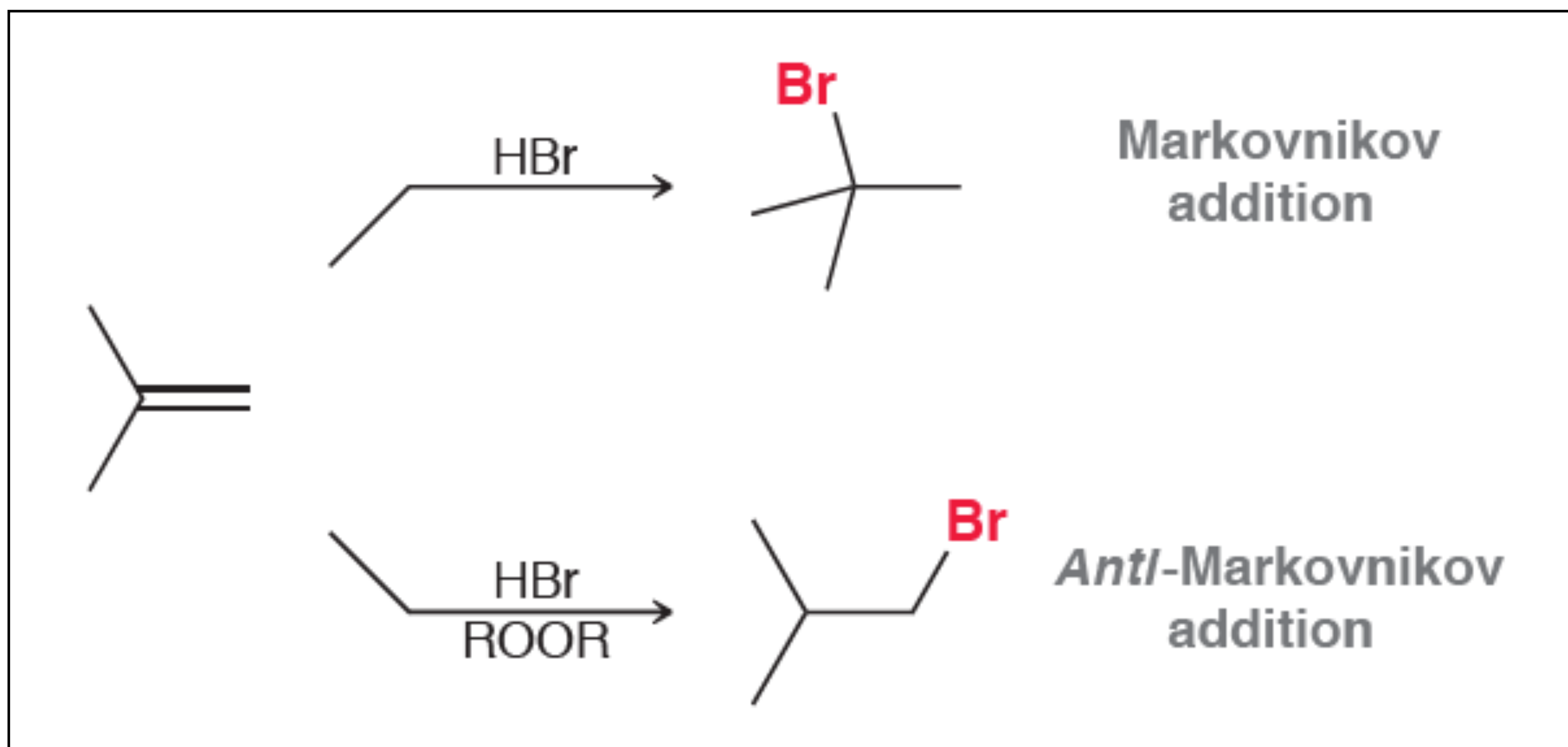


Esercizi: Proponi un meccanismo per ogni reazione a seguire.



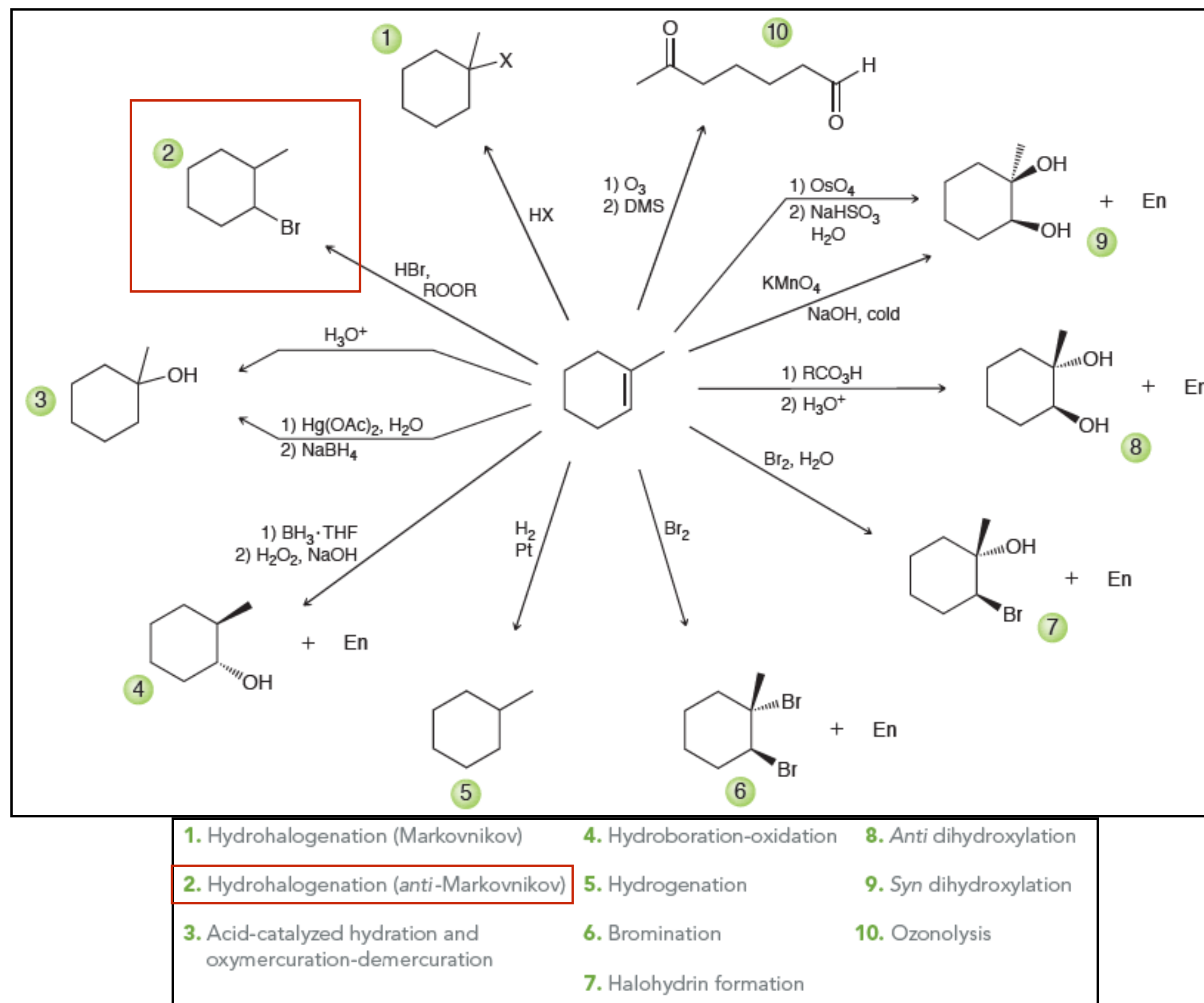
Regiosselettività di una reazione di addizione all'alchene:

Markovnikov e Anti-Markovnikov



Regiosselettività di una reazione di addizione all'alchene:

Markovnikov e Anti-Markovnikov



Regiosseletividade di una reazione di addizione all'alchene Anti-Markovnikov

A reação global:

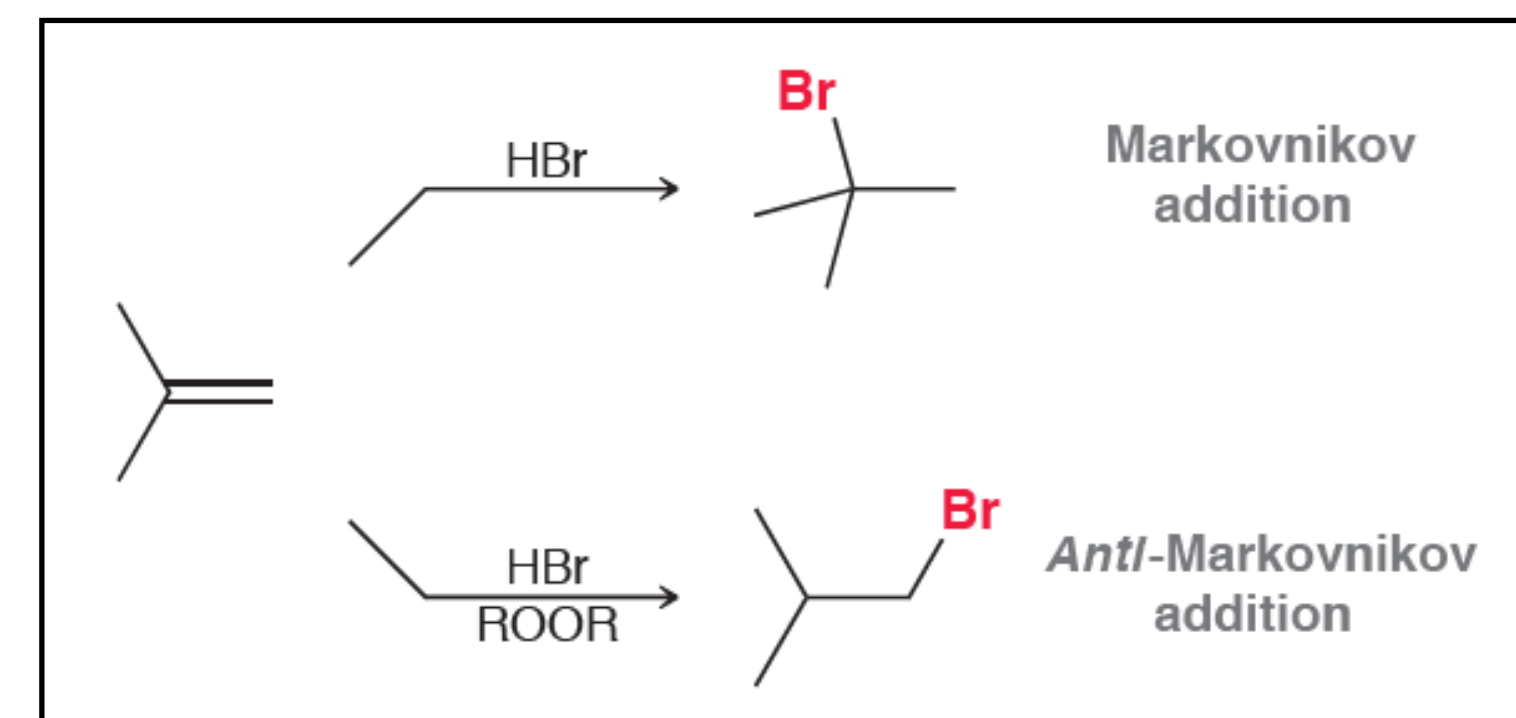
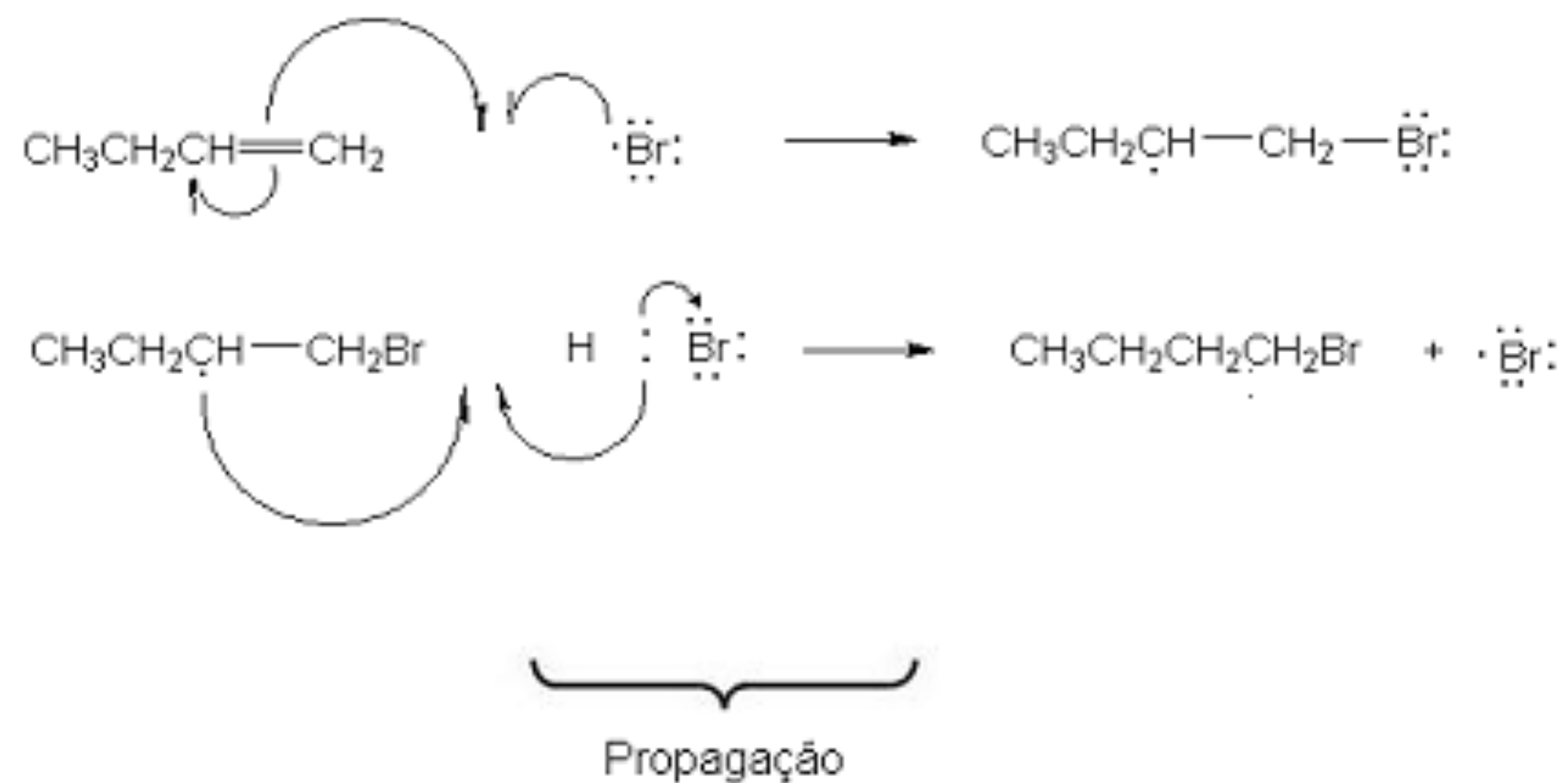
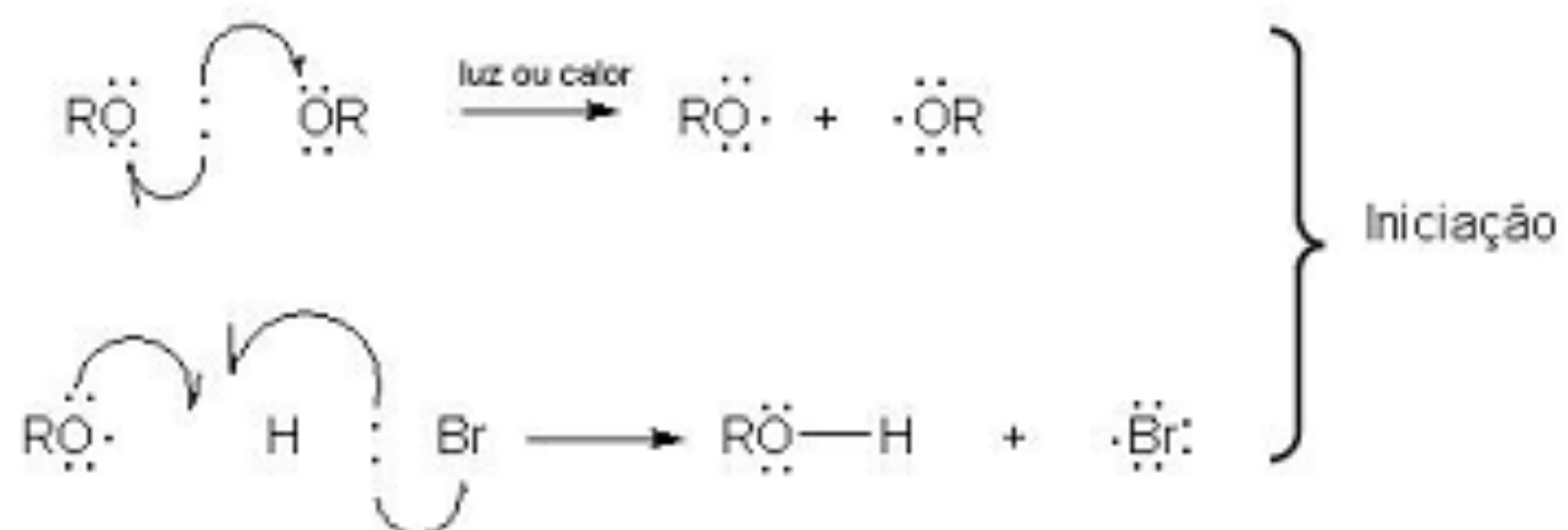


1- buteno

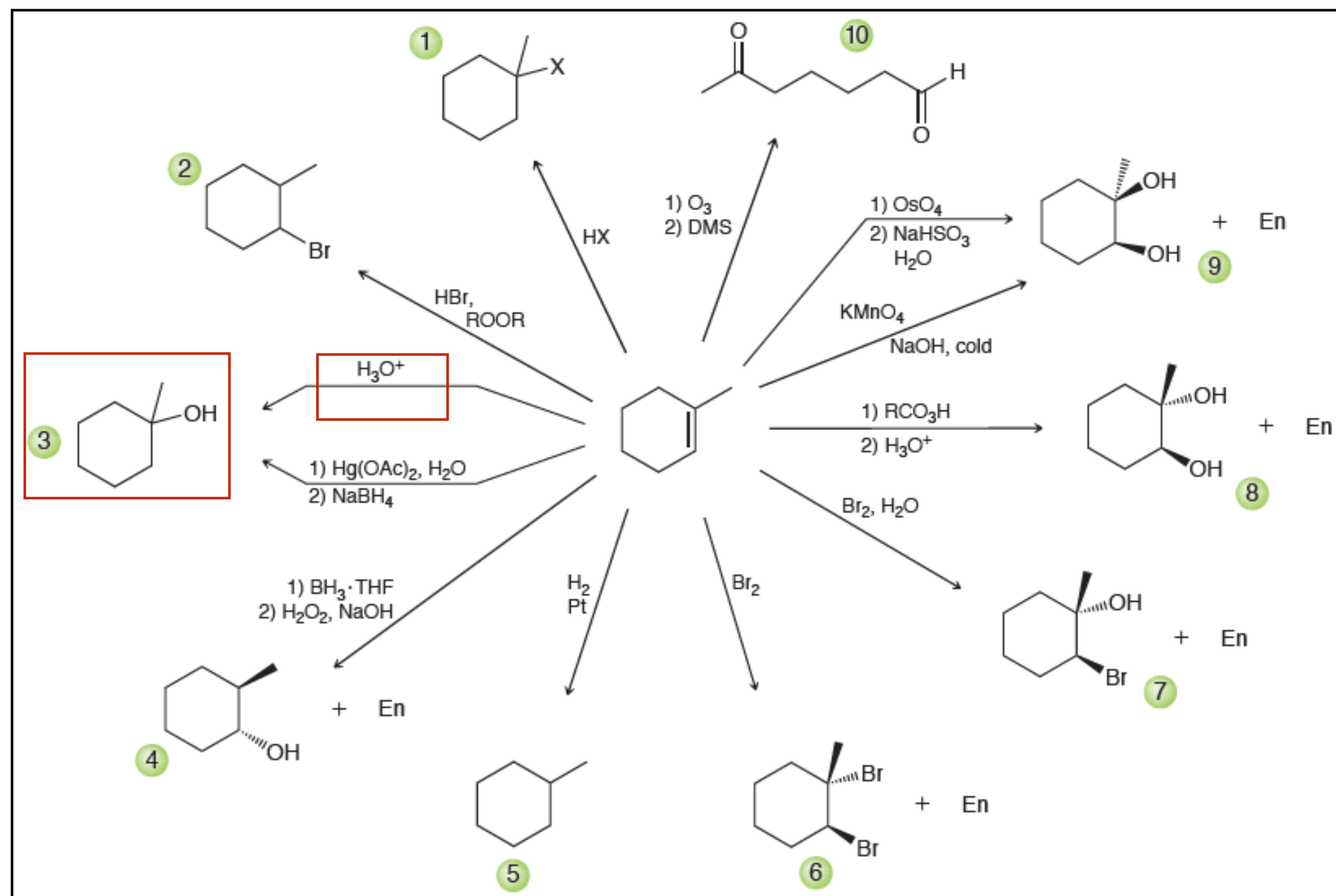
Brometo de
hidrogênio

2-bromobutano

Mecanismo:

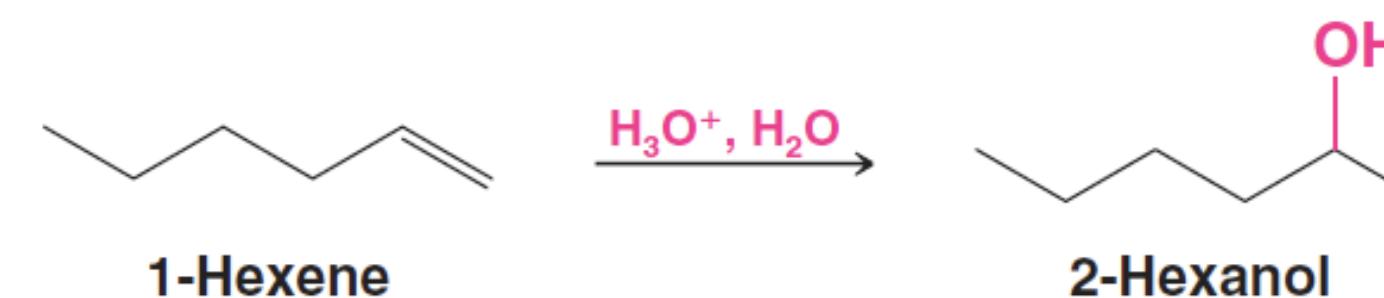
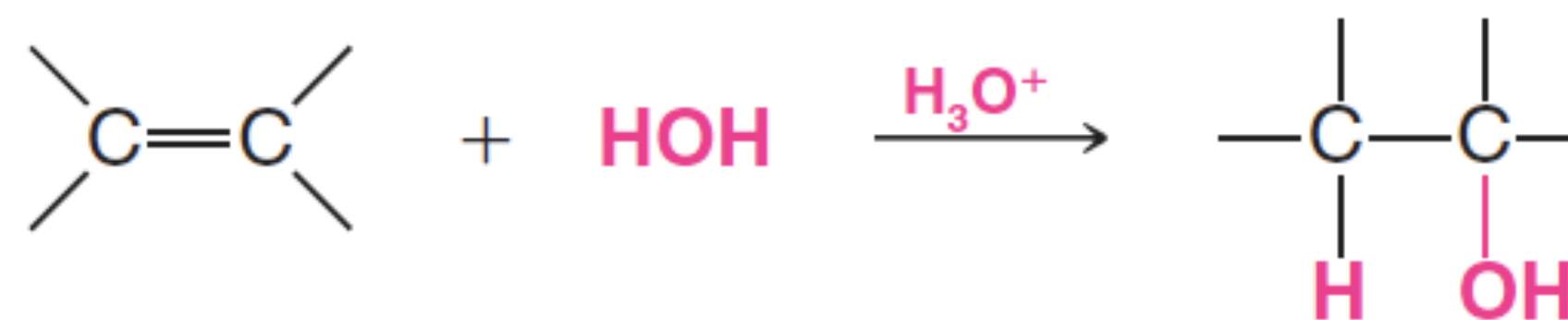
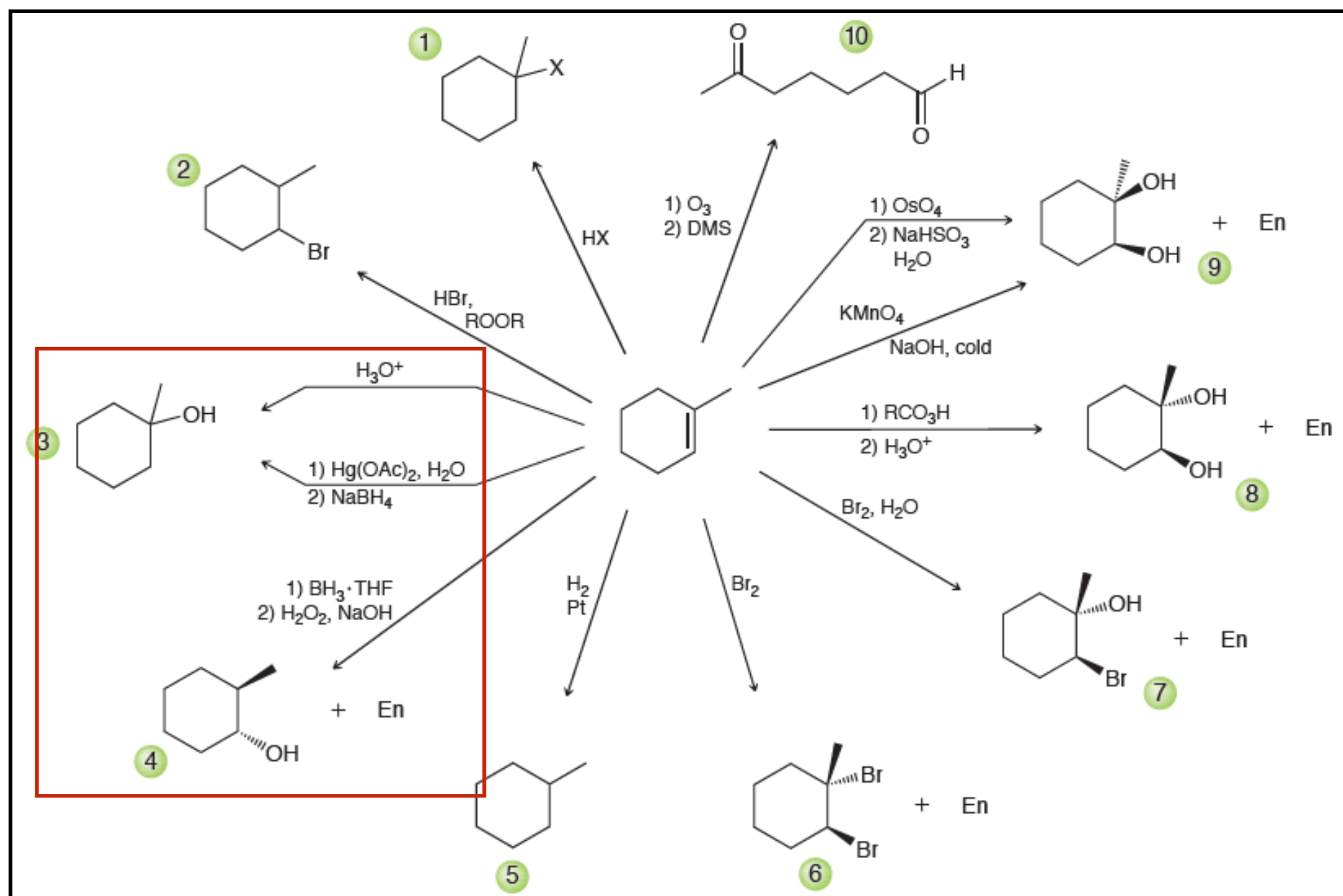


ADDIZIONE DI ACQUA AGLI ALCHENI

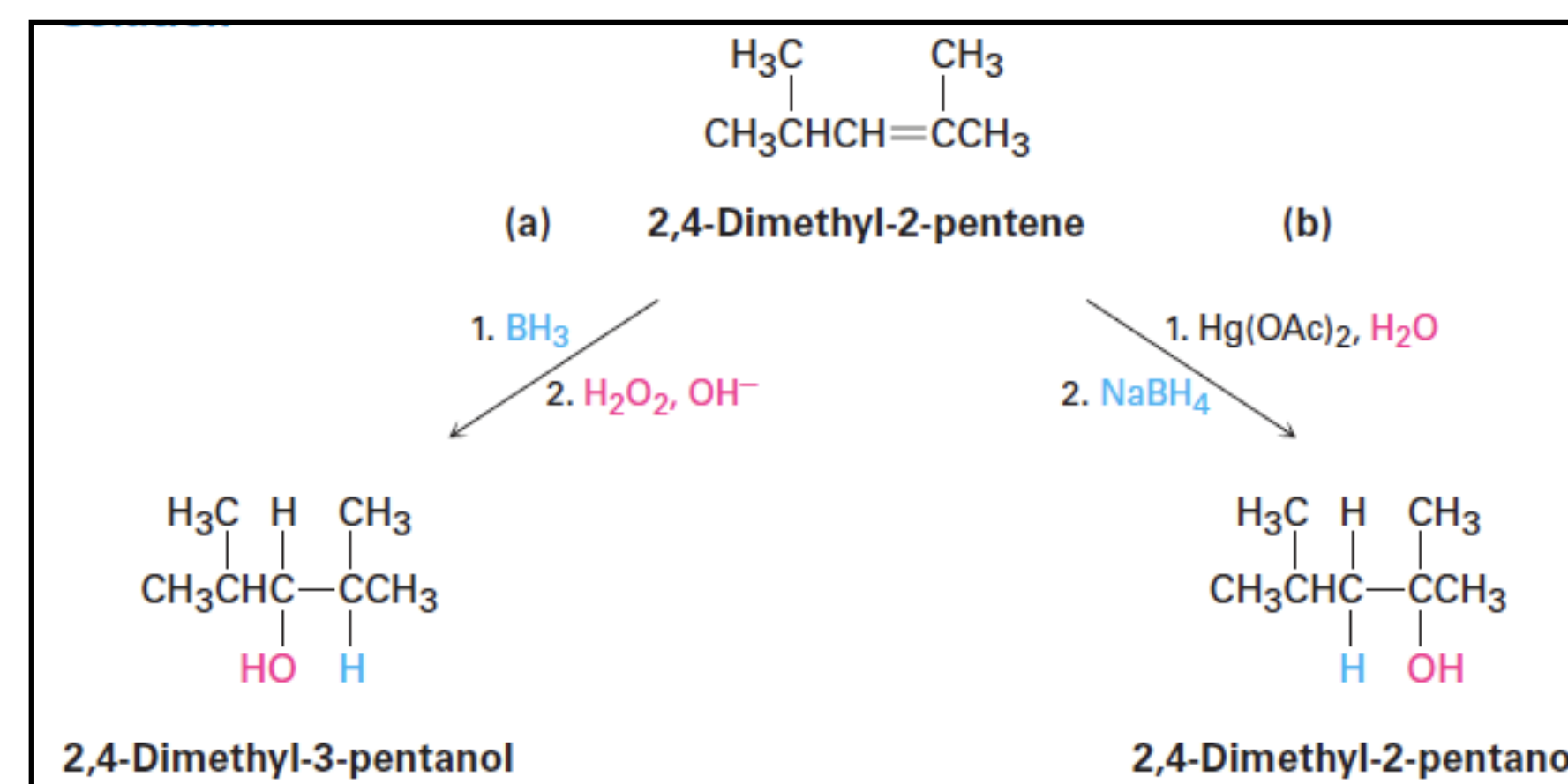


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|--|----------------------------|-------------------------|
| 1. Hydrohalogenation (Markovnikov) | 4. Hydroboration-oxidation | 8. Anti dihydroxylation |
| 2. Hydrohalogenation (anti-Markovnikov) | 5. Hydrogenation | 9. Syn dihydroxylation |
| 3. Acid-catalyzed hydration and oxymercuration-demercuration | 6. Bromination | 10. Ozonolysis |
| | 7. Halohydrin formation | |

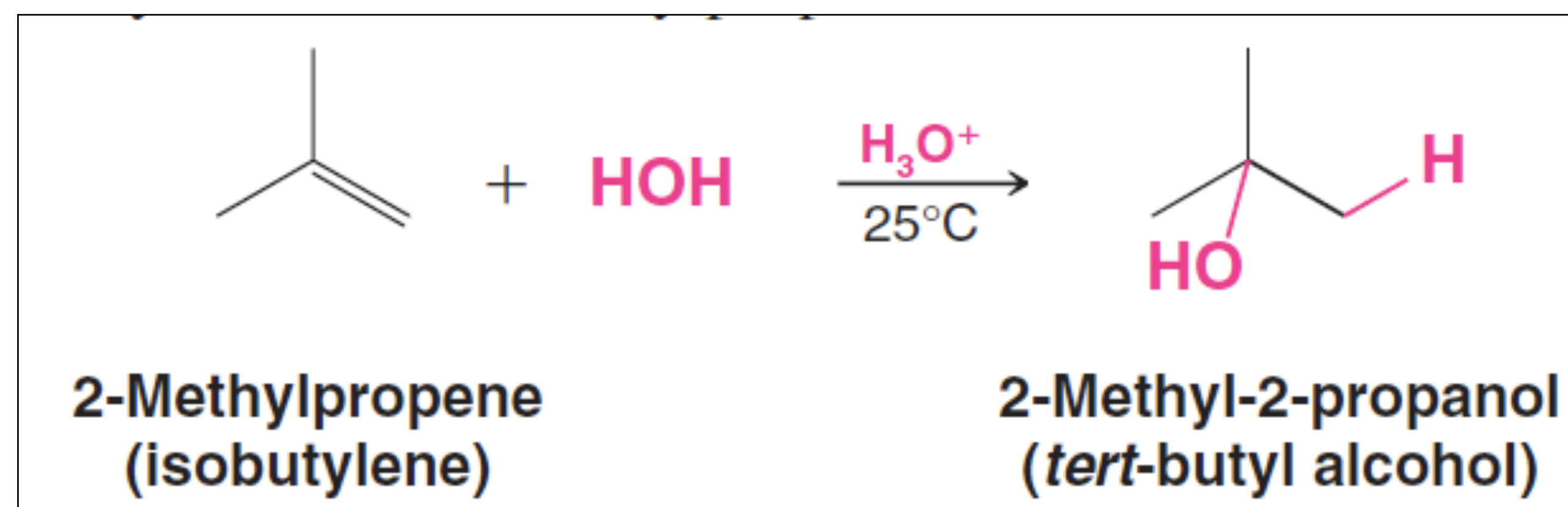
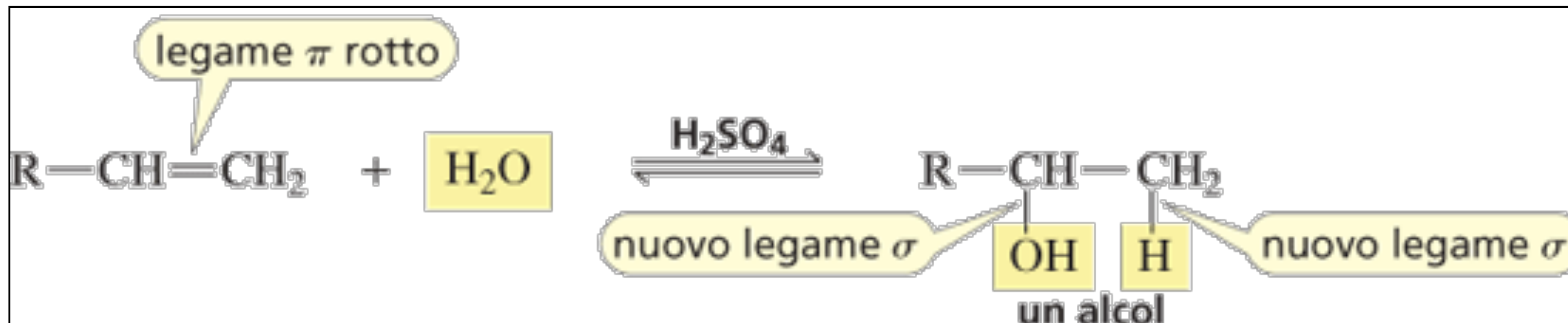
ADDIZIONE DI ACQUA AGLI ALCENI: IDRATAZIONE DEL DOPPIO LEGAME



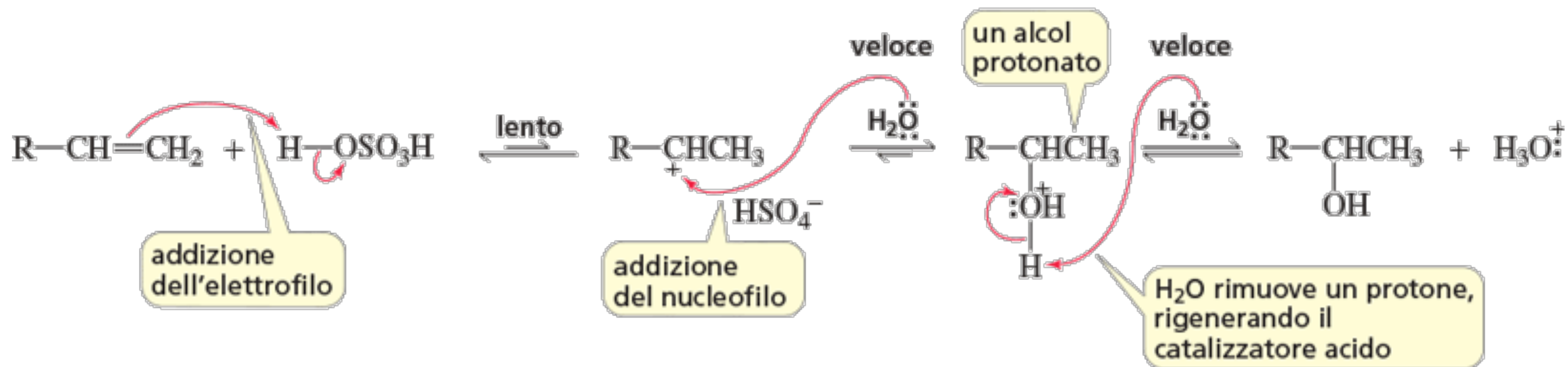
1. Idratazione catalizzata da acidi (Regola Markonivkov)
2. Ossimercurazione-Demercurazione (Regola Markonivkov)
3. Idroborazione-Ossidazione (Addizione SIN Anti-Markonikov)



ADDIZIONE DI ACQUA AGLI ALCENI



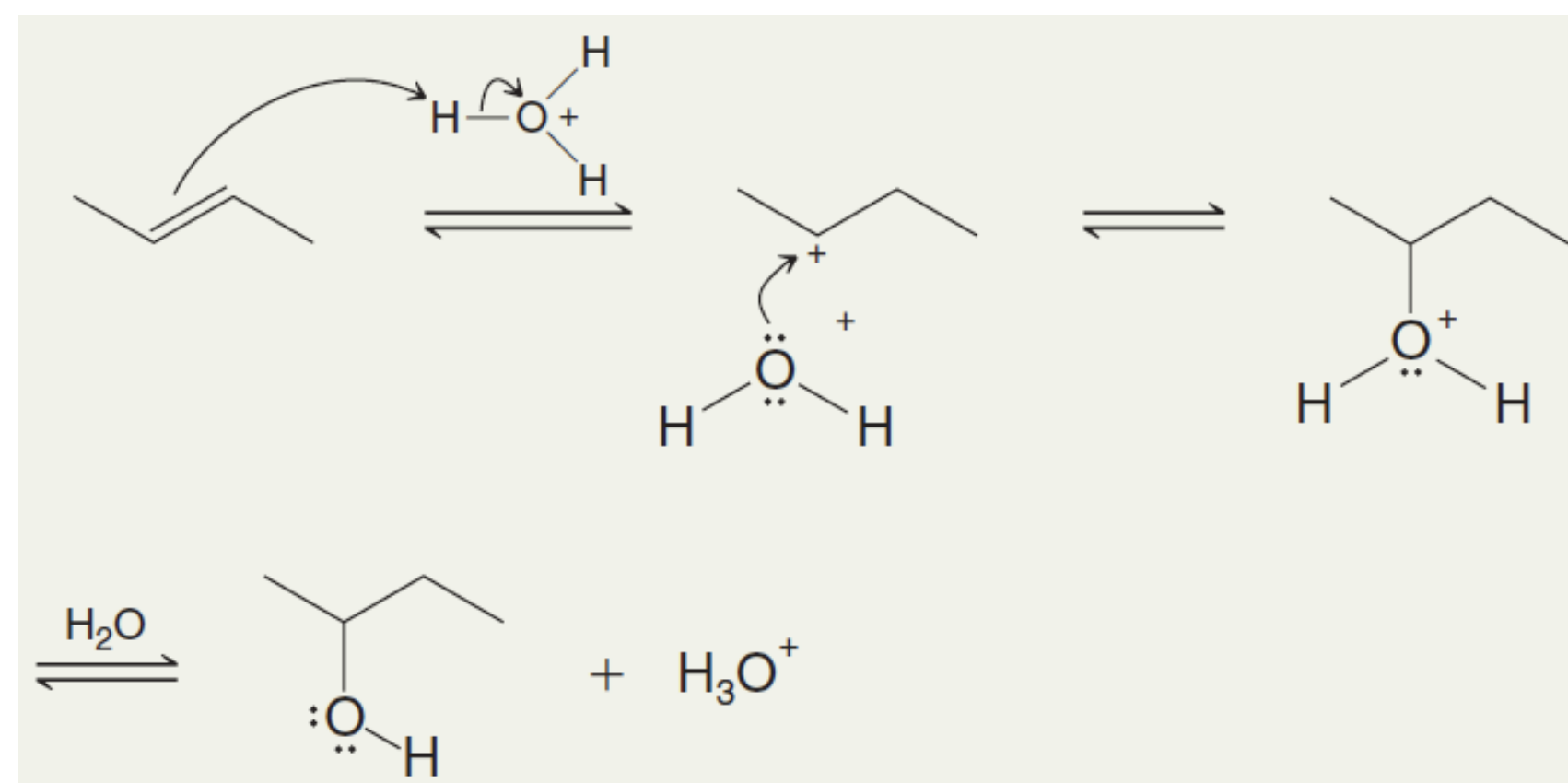
MECCANISMO DELL'ADDIZIONE DI ACQUA AGLI ALCENI CATALIZZATA DA ACIDI



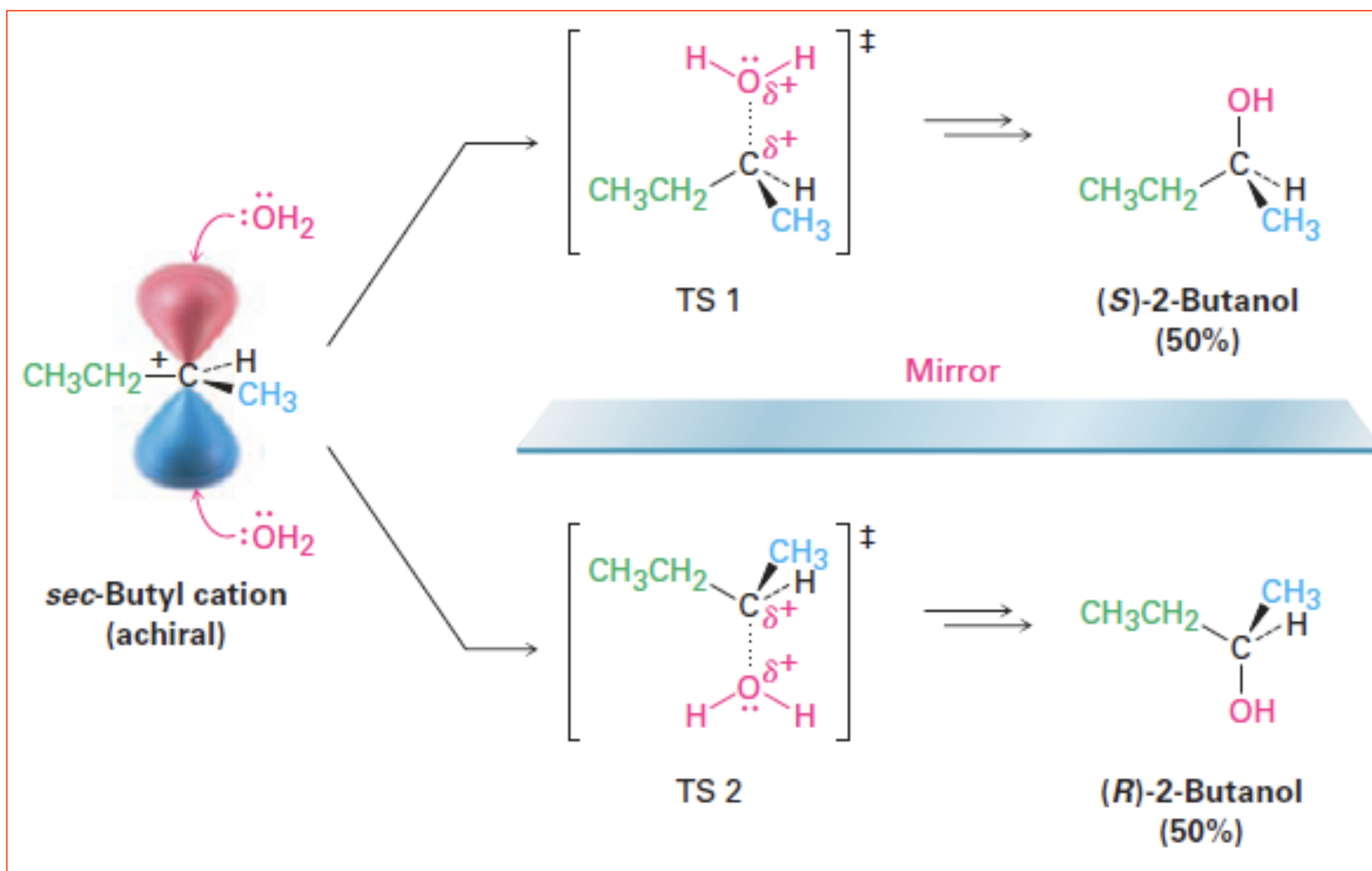
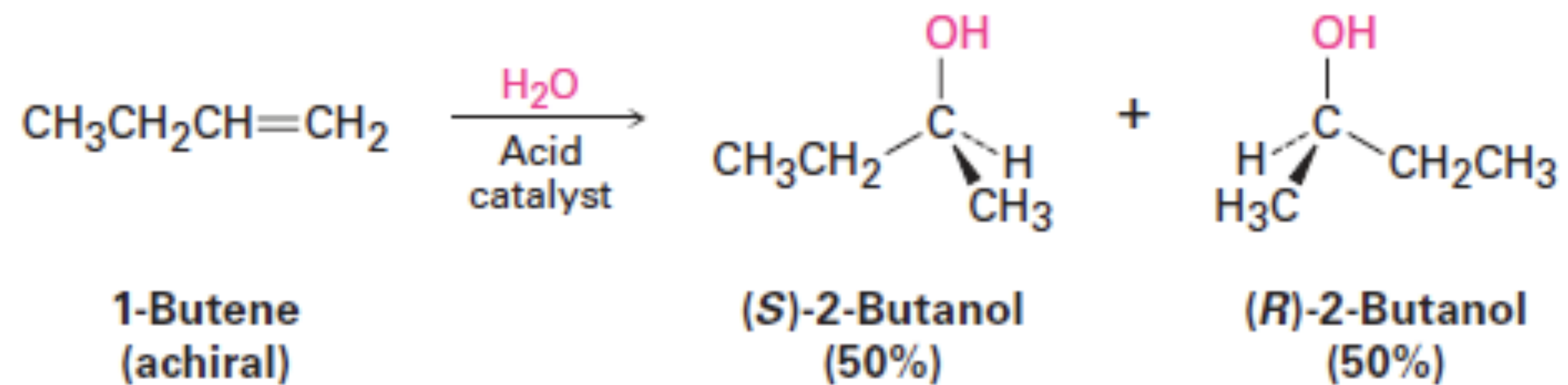
L'H⁺ (l'elettrofilo) si addiziona al carbonio sp² dell'alchene (il nucleofilo) che è legato al maggior numero di idrogeni.

L'H₂O (il nucleofilo) si addiziona al carbocatione (l'elettrofilo) formando un alcol protonato.

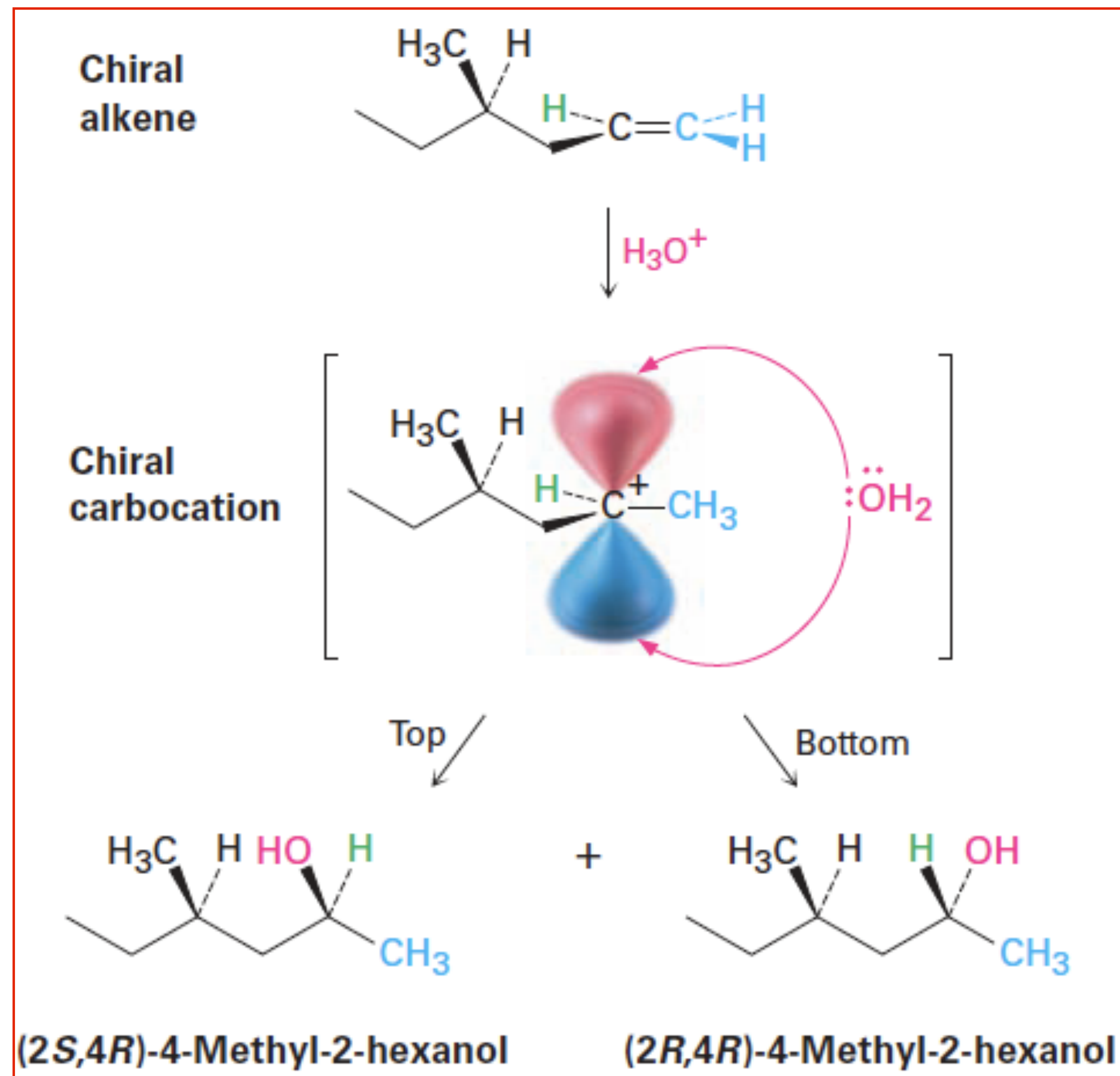
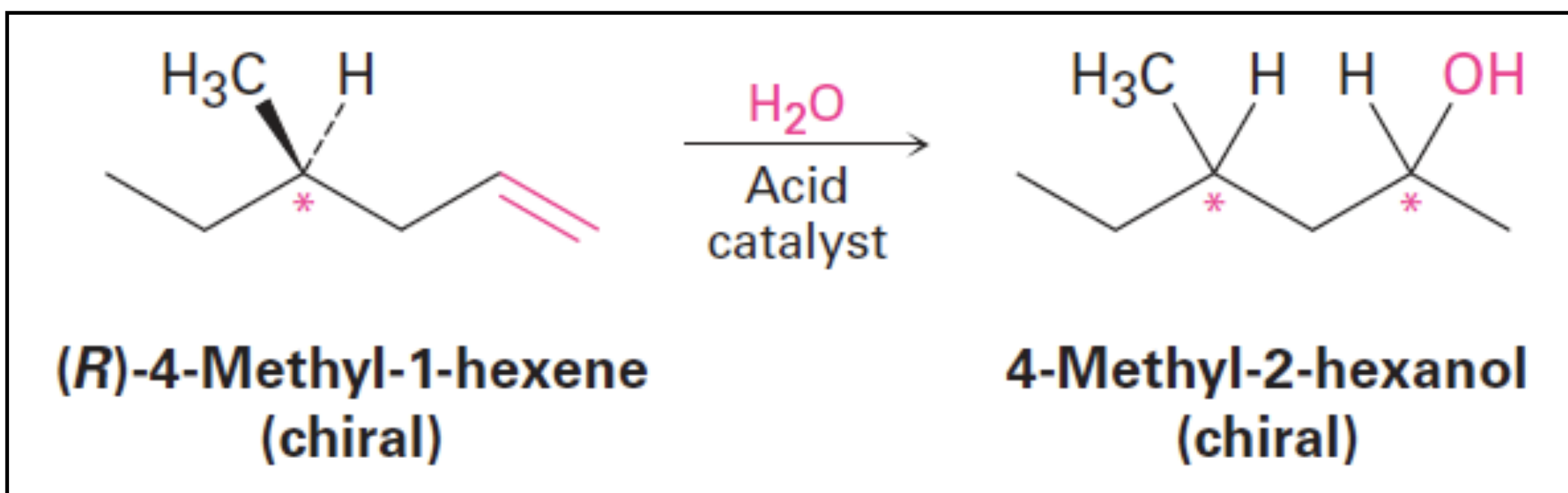
L'alcol protonato perde un protone perché il pH della soluzione è più alto del valore di pK_a dell'alcol protonato



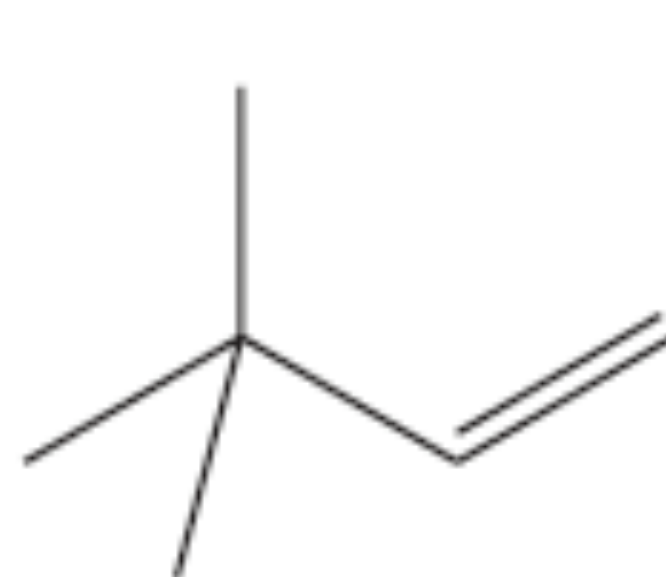
STEREOCHIMICA DELL'IDRATAZIONE ACIDA CATALIZZATA



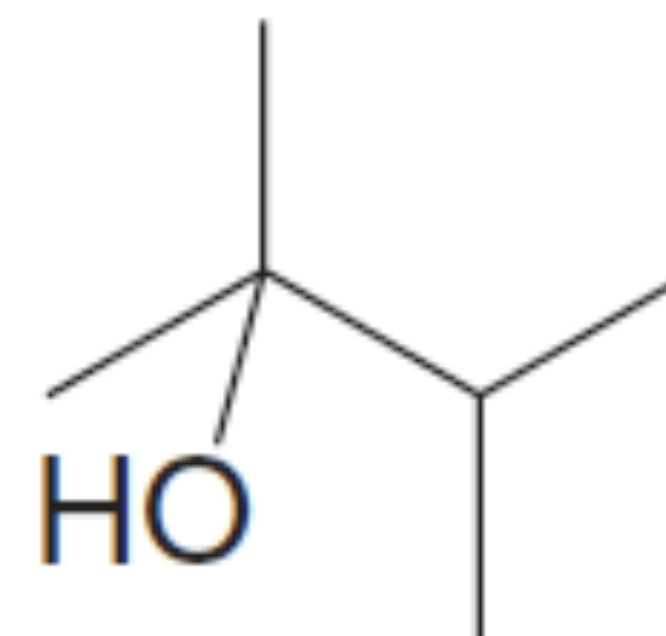
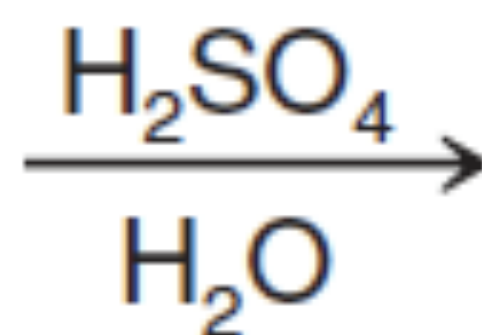
STEREOCHIMICA DELL'IDRATAZIONE ACIDA CATALIZZATA



ATTENZIONE AD UNA POSSIBILE TRASPOSIZIONE DURANTE L'IDRATAZIONE ACIDA CATALIZZATA

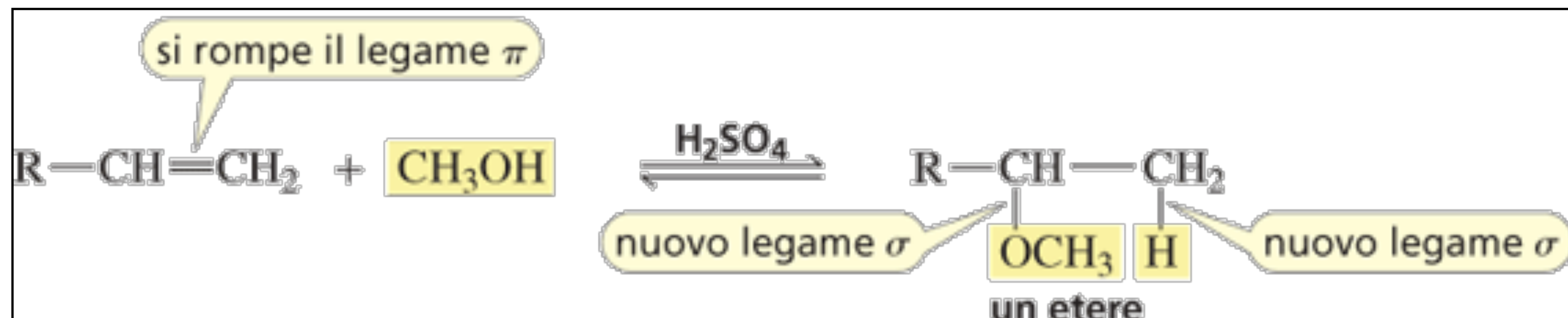


3,3-Dimethyl-1-butene

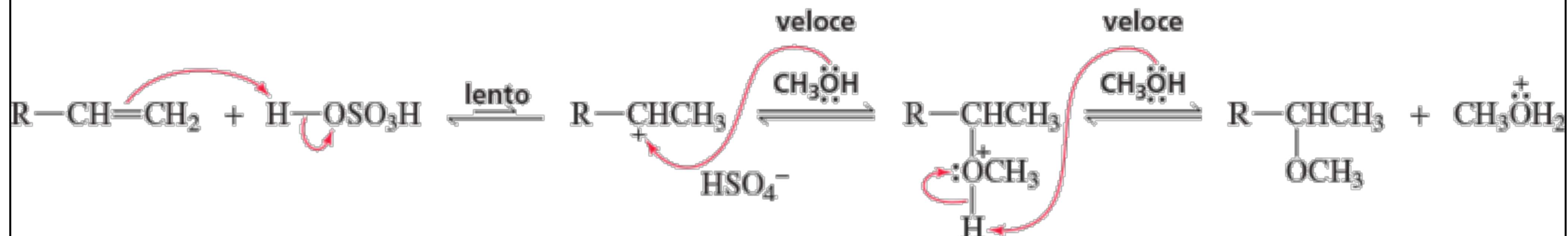


**2,3-Dimethyl-2-butanol
(major product)**

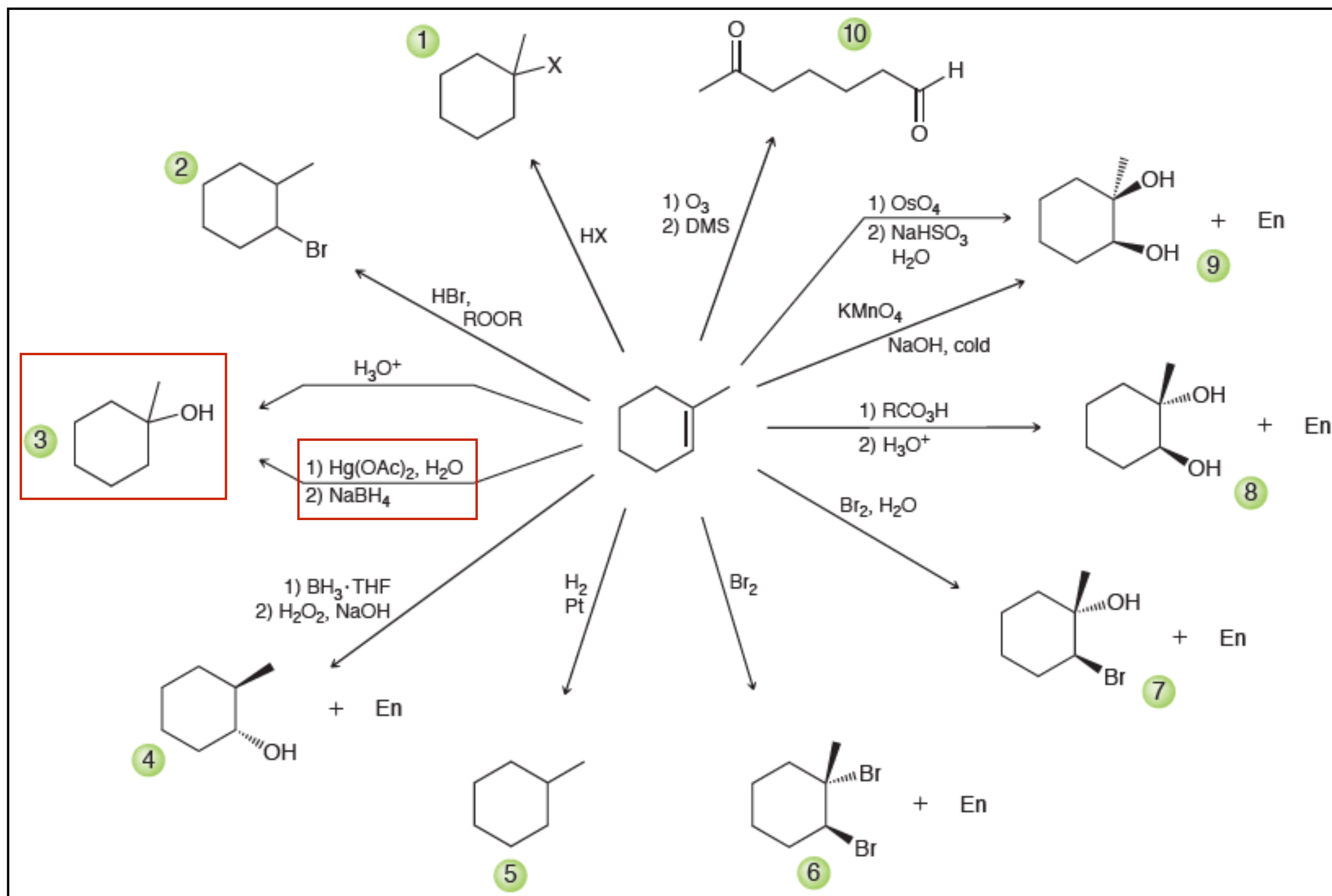
ADDIZIONE DI ALCOL AGLI ALCENI



MECCANISMO DELL'ADDIZIONE DI ALCOL AGLI ALCENI CATALIZZATA DA ACIDI

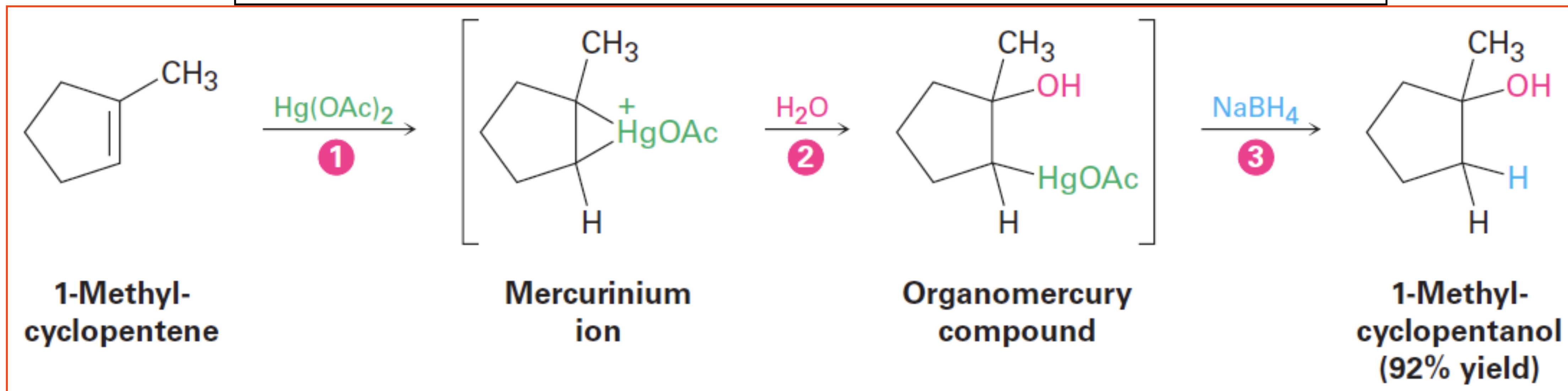
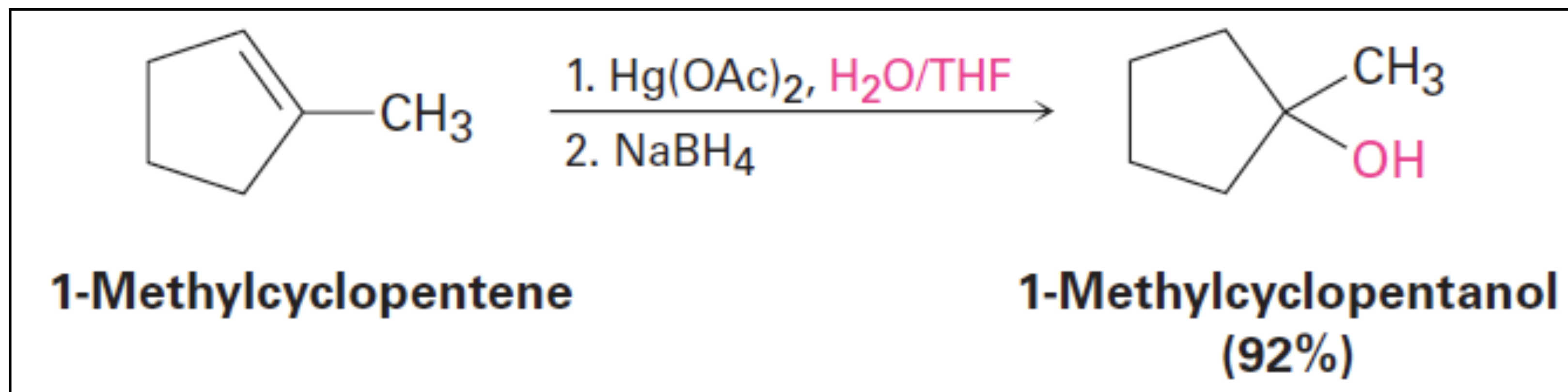
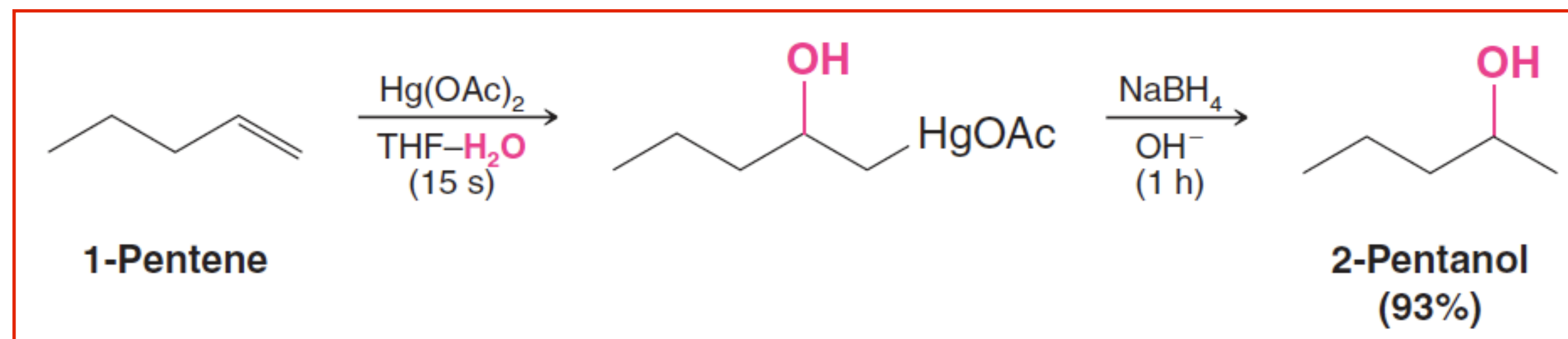


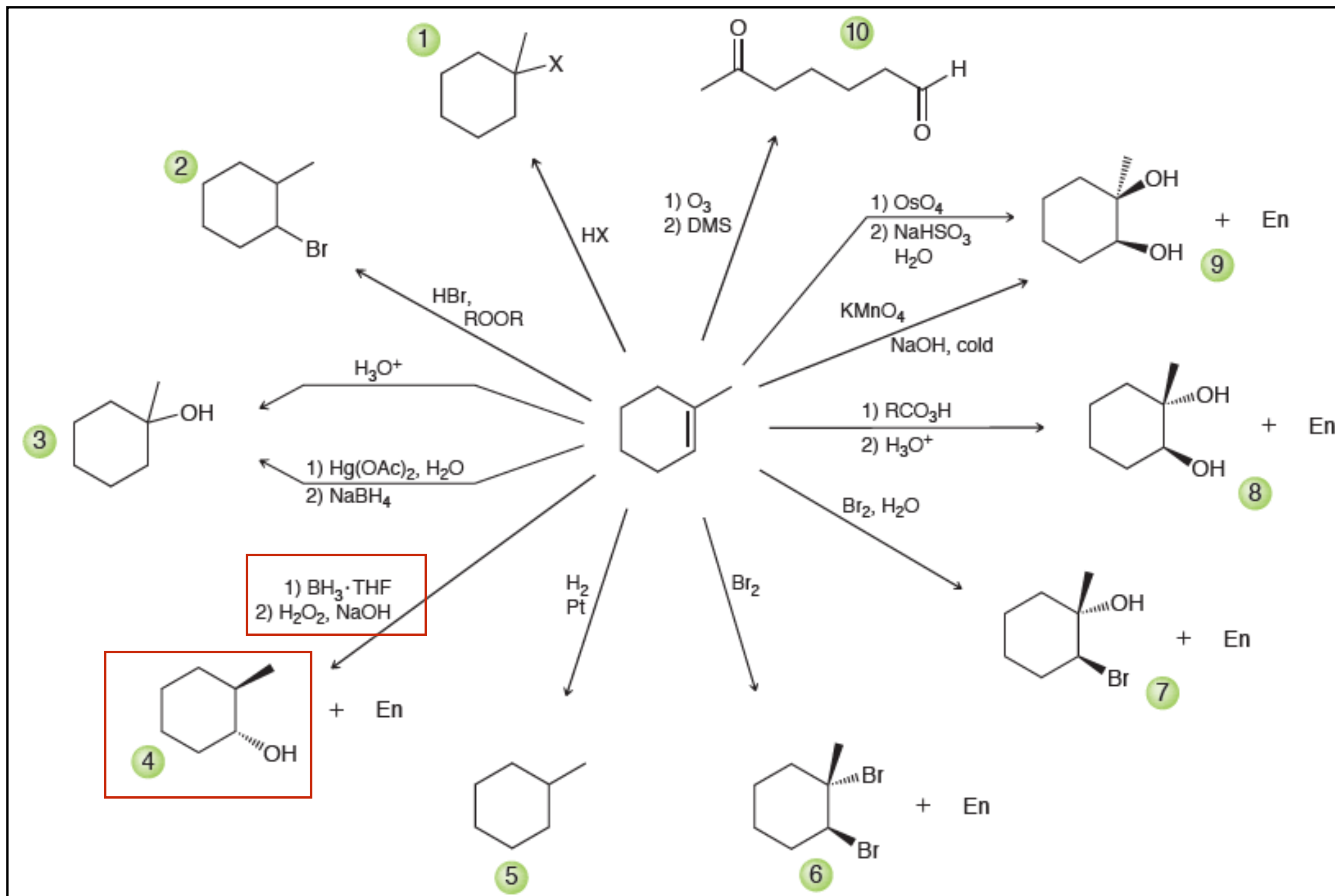
IDRATAZIONE DI UN ALCHENE VIA IONE MERCURINO



- | | | |
|--|----------------------------|-------------------------|
| 1. Hydrohalogenation (Markovnikov) | 4. Hydroboration-oxidation | 8. Anti dihydroxylation |
| 2. Hydrohalogenation (anti-Markovnikov) | 5. Hydrogenation | 9. Syn dihydroxylation |
| 3. Acid-catalyzed hydration and oxymercuration-demercuration | 6. Bromination | 10. Ozonolysis |
| | 7. Halohydrin formation | |

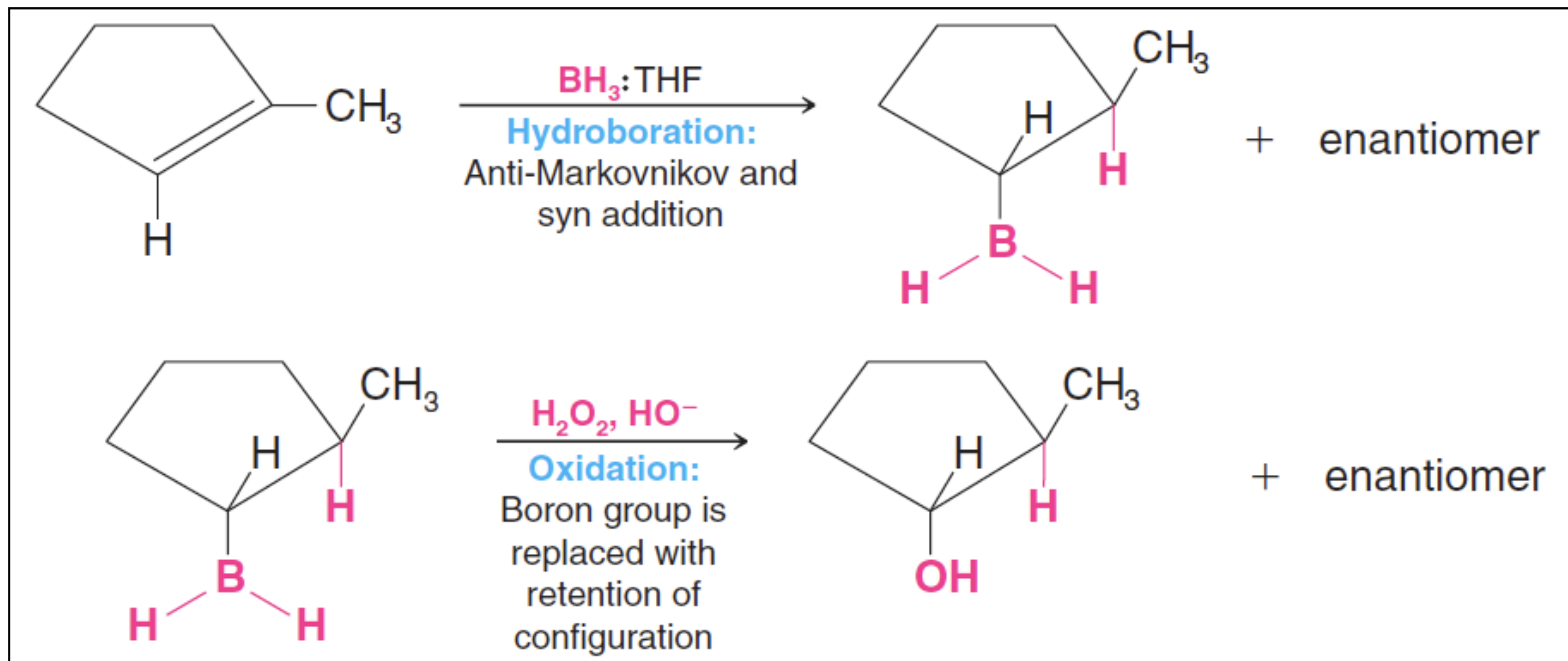
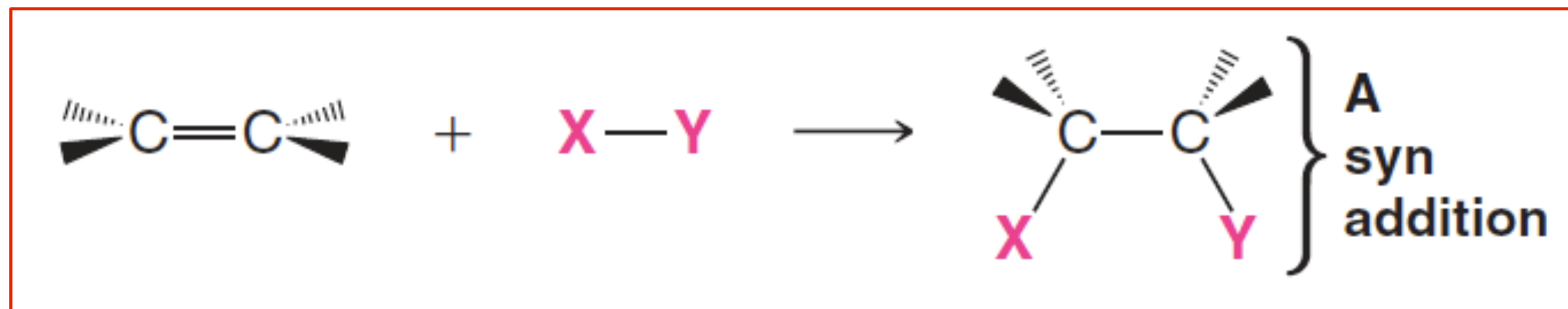
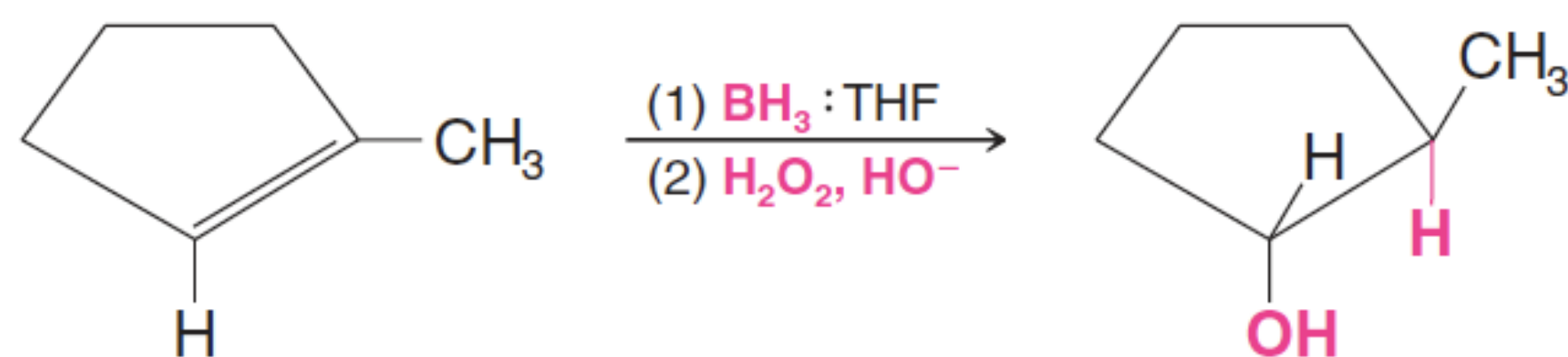
IDRATAZIONE DI UN ALCHENE VIA IONE MERCURINO (REGOLA MARKONIKOV)



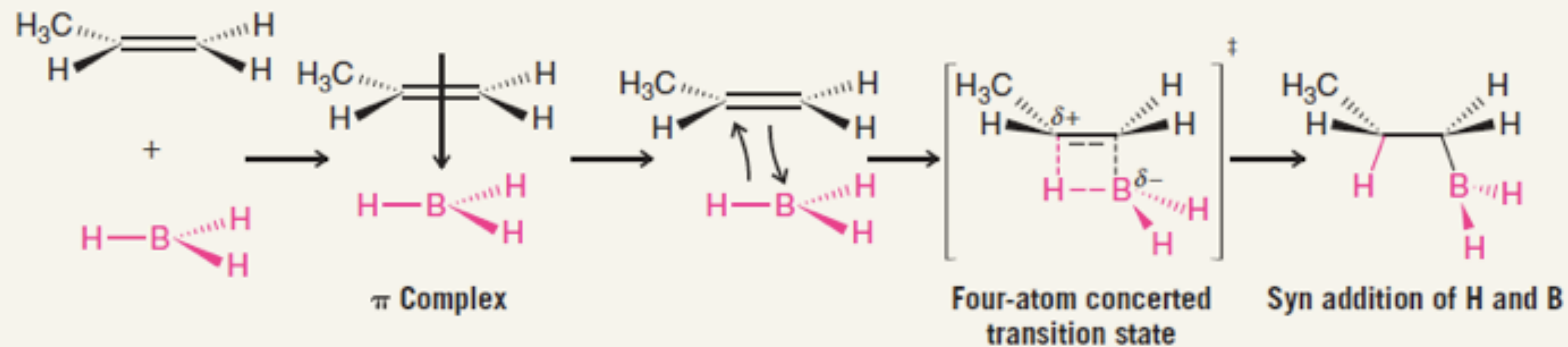


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|--|----------------------------|-------------------------|
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| 2. Hydrohalogenation (anti-Markovnikov) | 5. Hydrogenation | 9. Syn dihydroxylation |
| 3. Acid-catalyzed hydration and oxymercuration-demercuration | 6. Bromination | 10. Ozonolysis |
| | 7. Halohydrin formation | |

IDRATAZIONE DI UN ALCHENE VIA IDROBORAZIONE-OSSIDAZIONE (ADDIZIONE SIN E REGIOCHIMICA ANTI-MARKONIKOV)

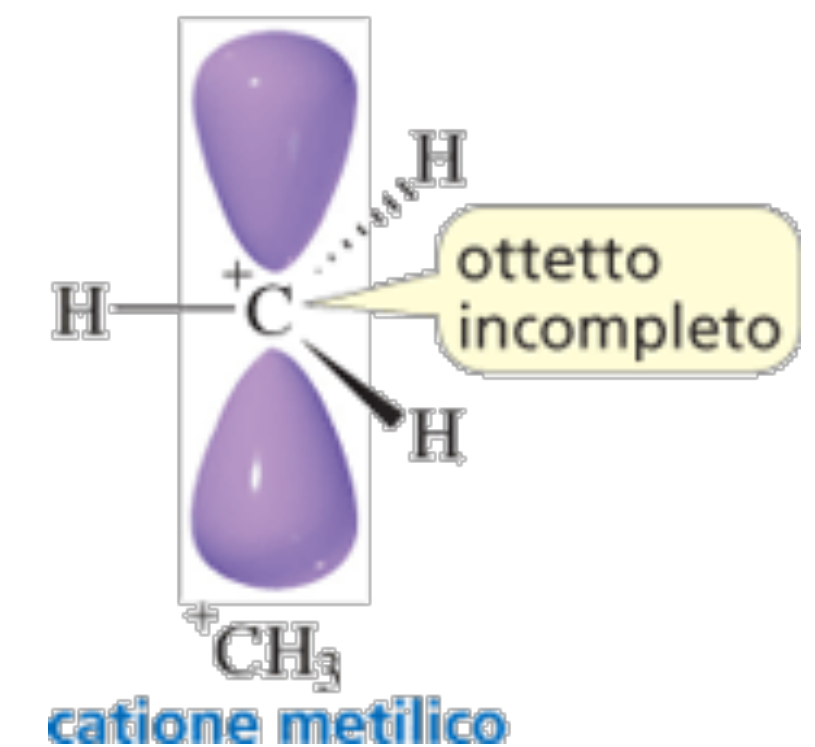
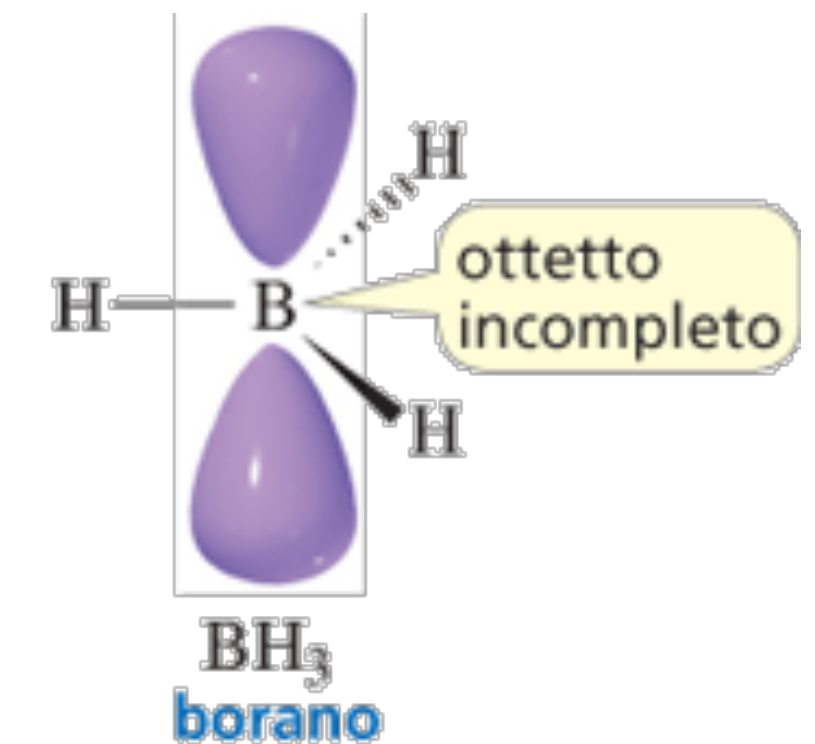
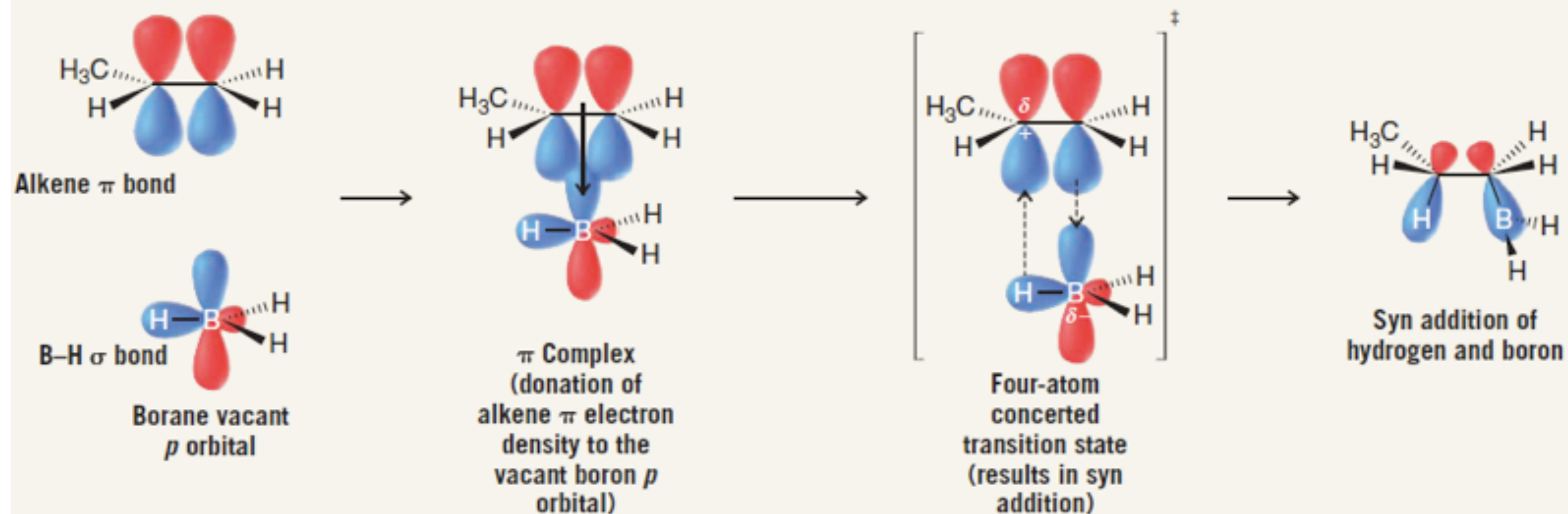


IDRATAZIONE DI UN ALCHENE VIA IDROBORAZIONE-OSSIDAZIONE (addizione S_{N} Anti-Markovnikov)

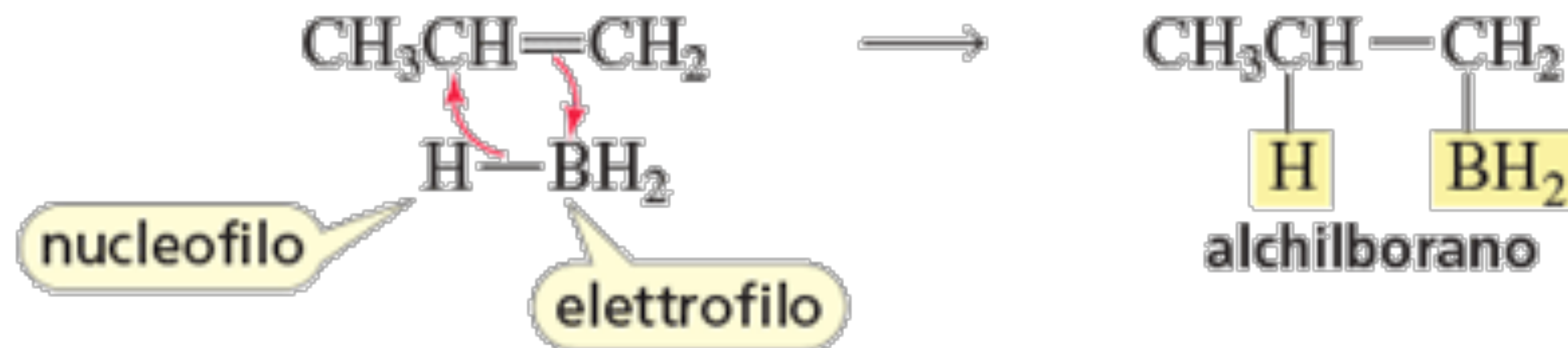


Addition takes place through the initial formation of a π complex, which changes into a cyclic four-atom transition state with the boron adding to the less hindered carbon atom. The dashed bonds in the transition state represent bonds that are partially formed or partially broken. The transition state results in syn addition of the hydrogen and boron group, leading to an alkylborane. The other B-H bonds of the alkylborane can undergo similar additions, leading finally to a trialkylborane.

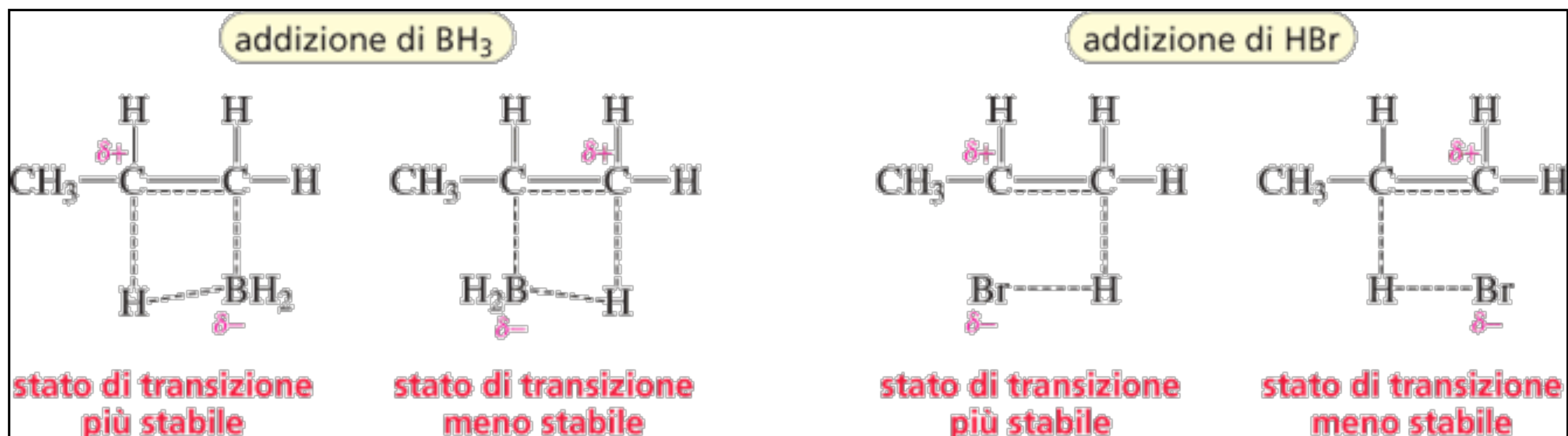
An orbital view of hydroboration



MECCANISMO DELL'IDROBORAZIONE CON BH_3



In una reazione concertata tutti i processi di formazione e di rottura dei legami avvengono nello stesso stadio.

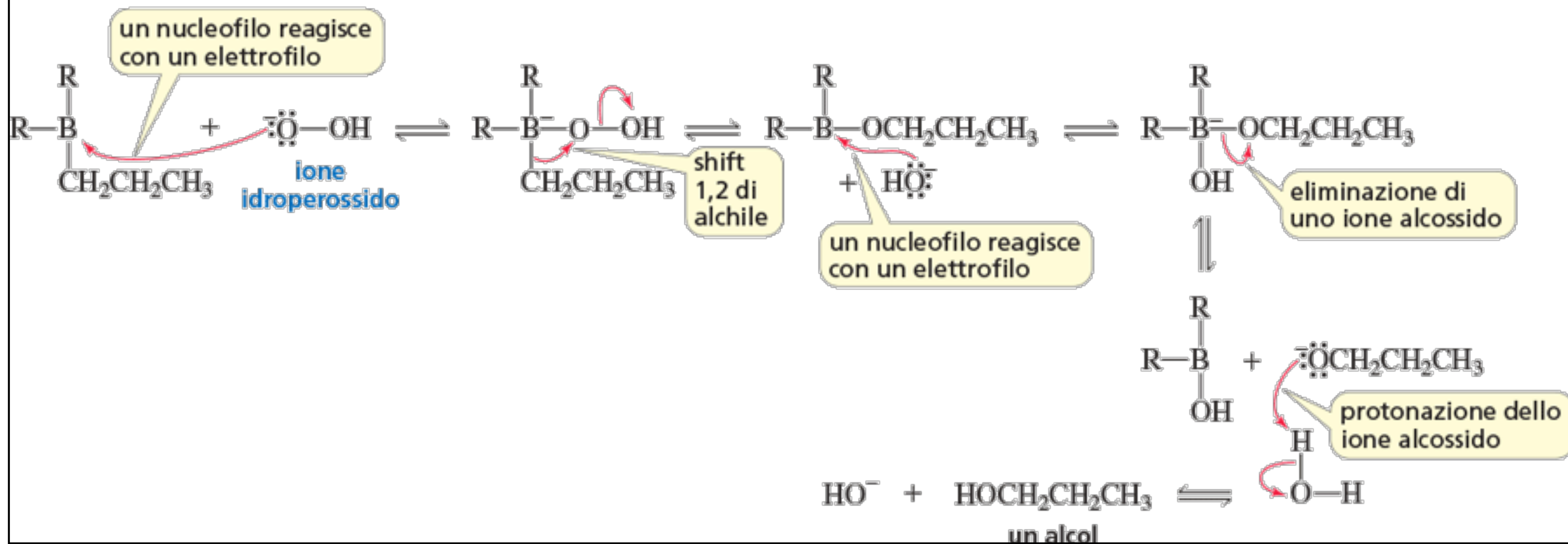


Ossidazione

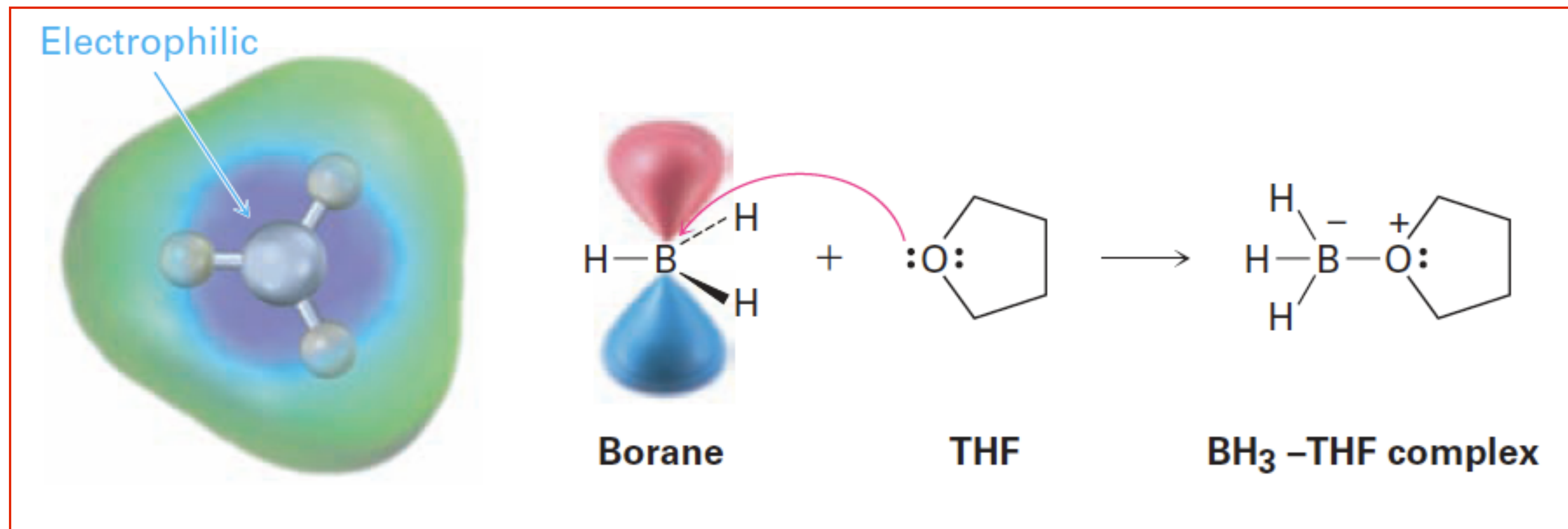
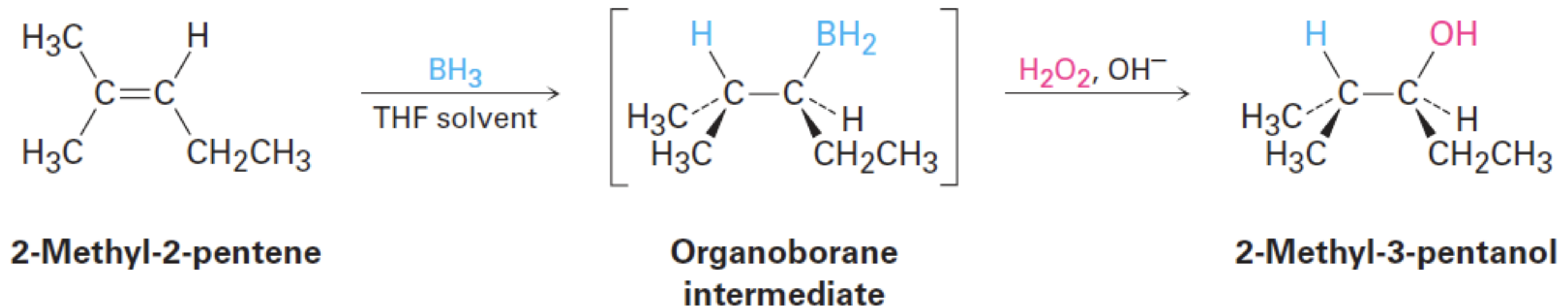
Quando la reazione di idroborazione è finita, si aggiunge alla miscela di reazione una soluzione acquosa di idrossido di sodio e perossido di idrogeno (HOOH) per sostituire il BR₂ con il gruppo OH.



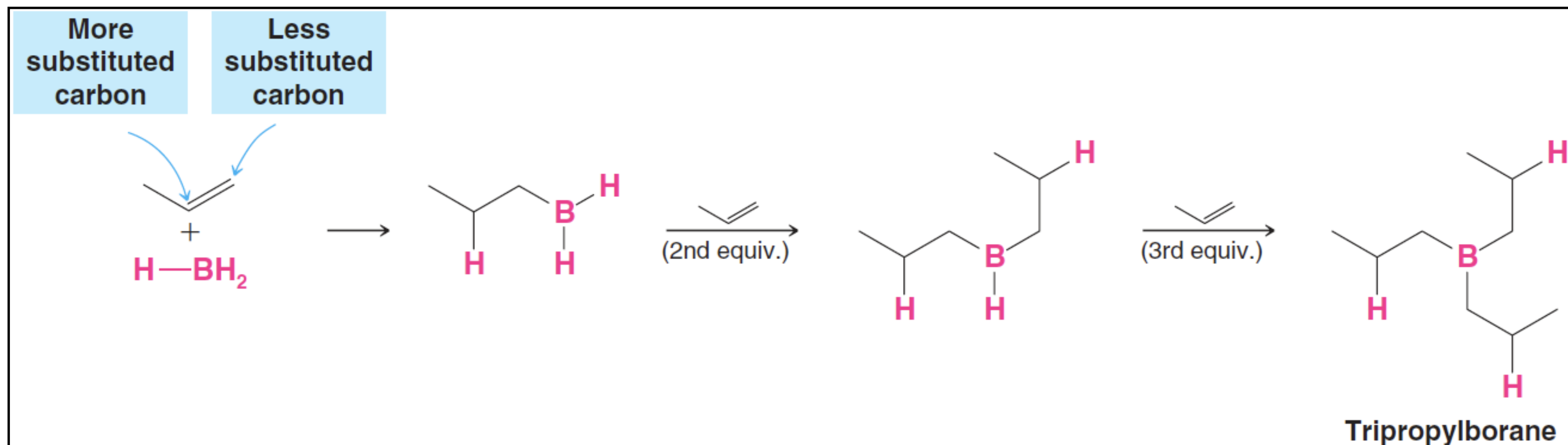
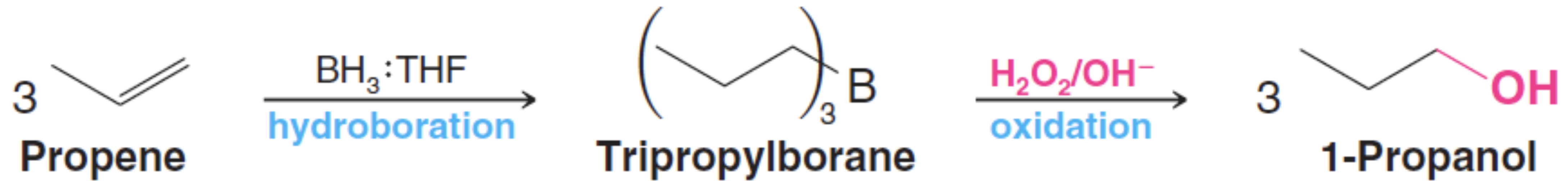
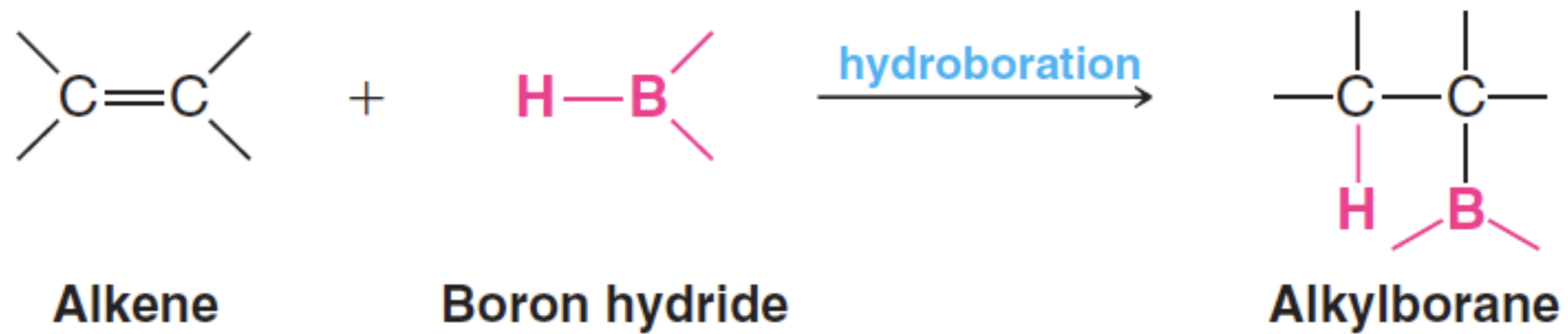
MECCANISMO DELLA REAZIONE DI OSSIDAZIONE

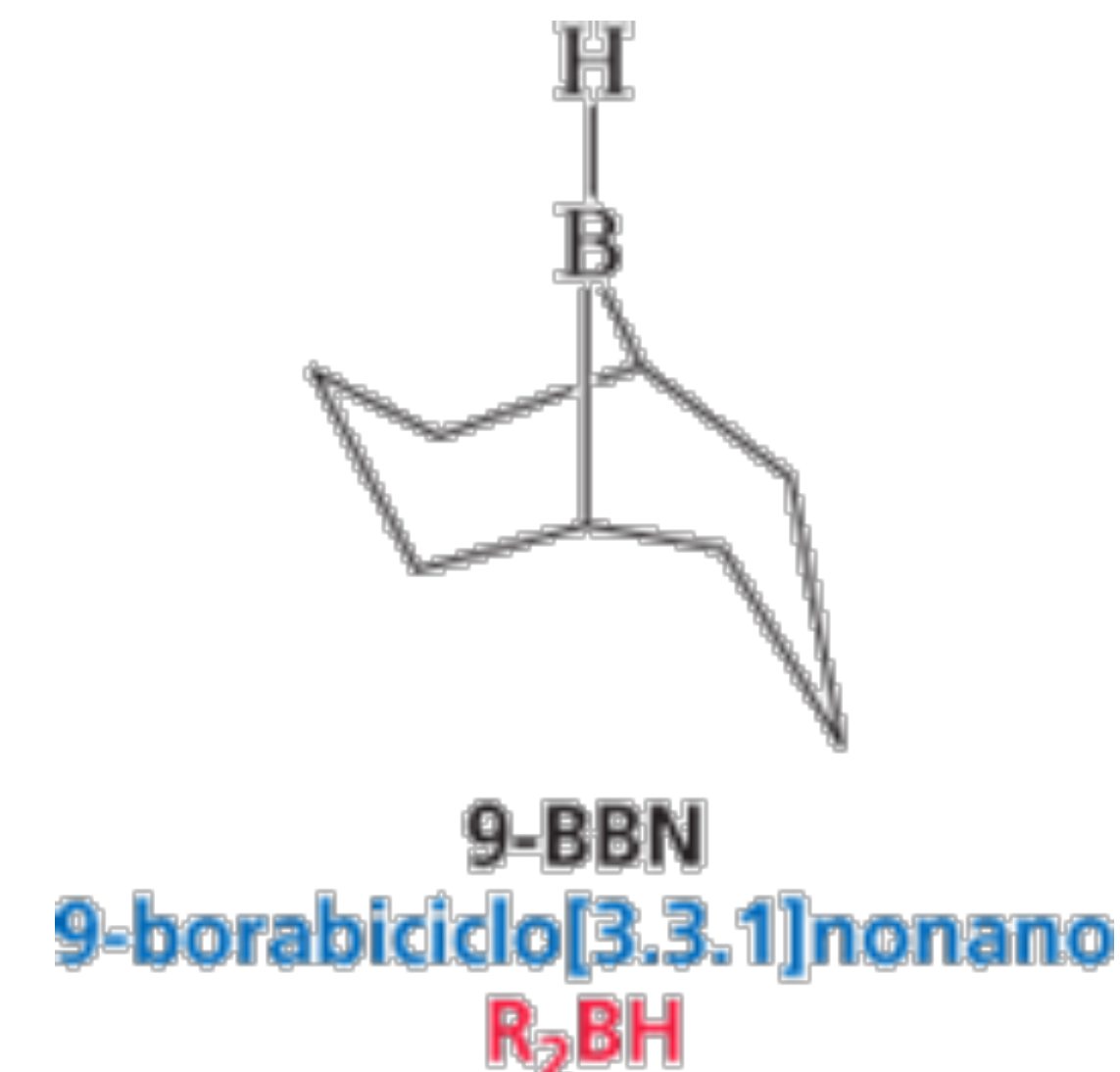
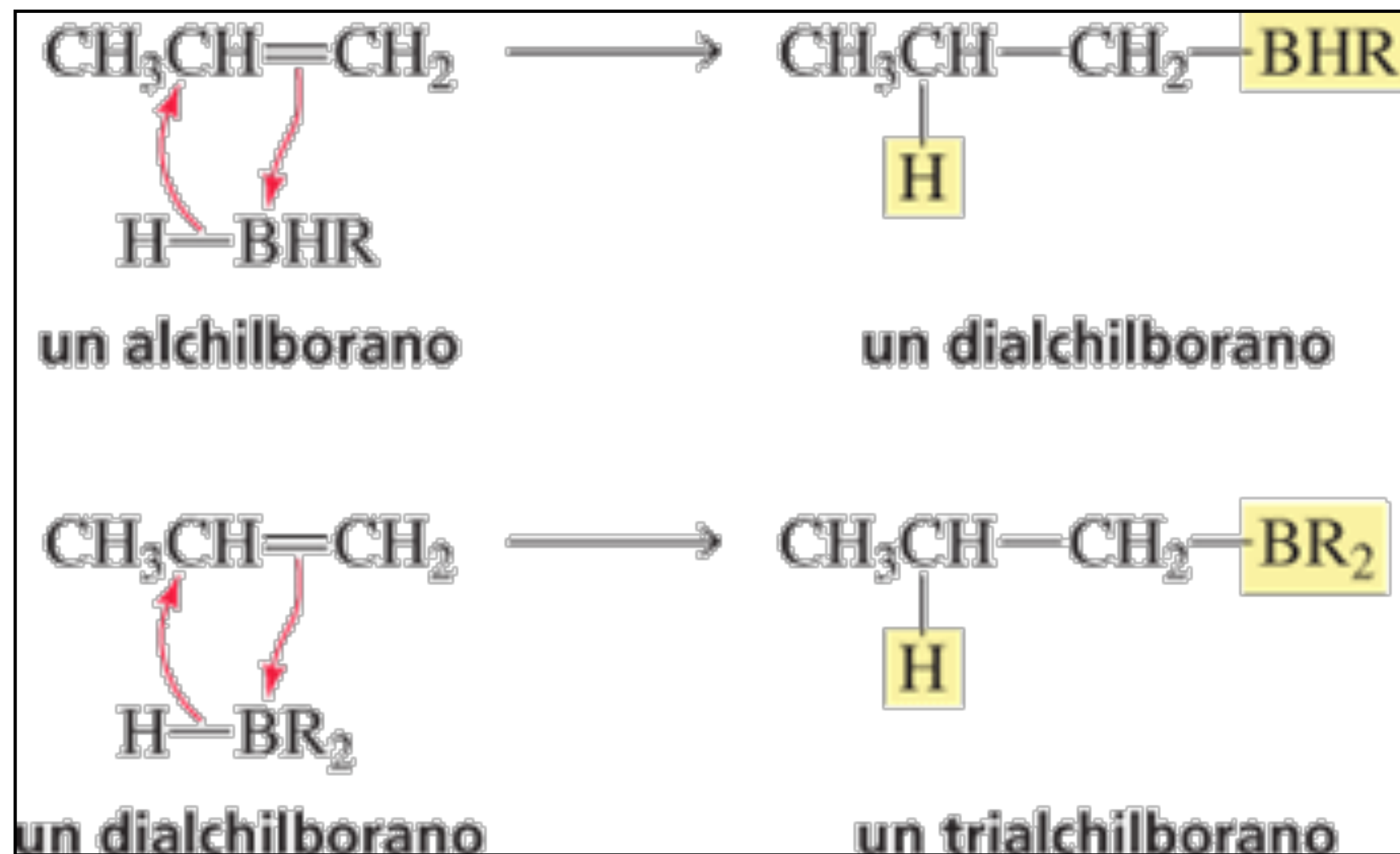


IDRATAZIONE DI UN ALCHENE VIA IDROBORAZIONE-OSSIDAZIONE (addizione S_{N} Anti-Markovnikov)

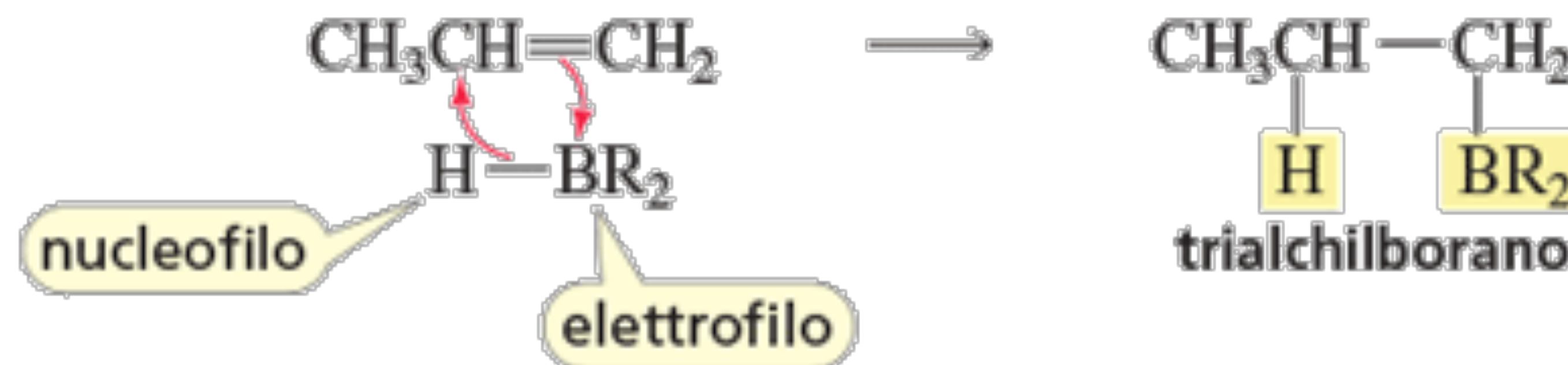


IDRATAZIONE DI UN ALCHENE VIA IDROBORAZIONE-OSSIDAZIONE (addizione S_{N} Anti-Markovnikov)

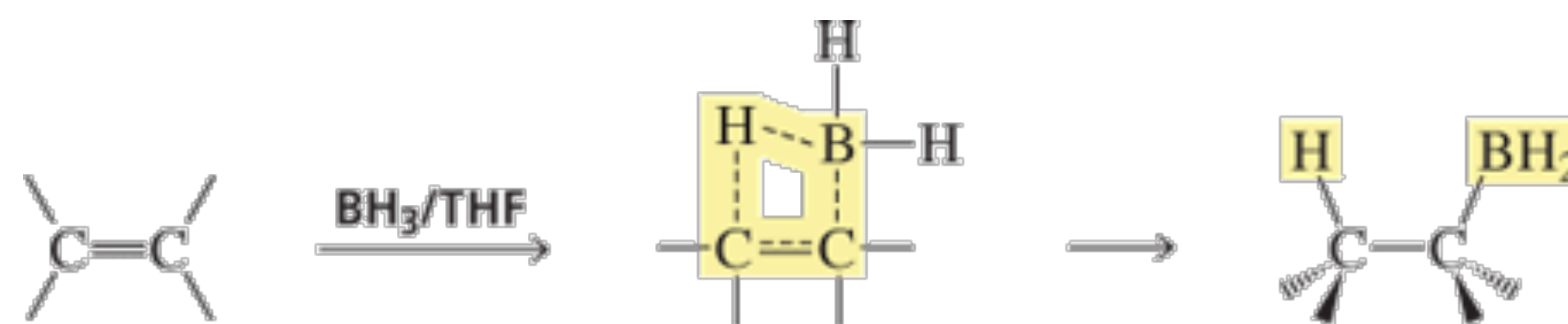
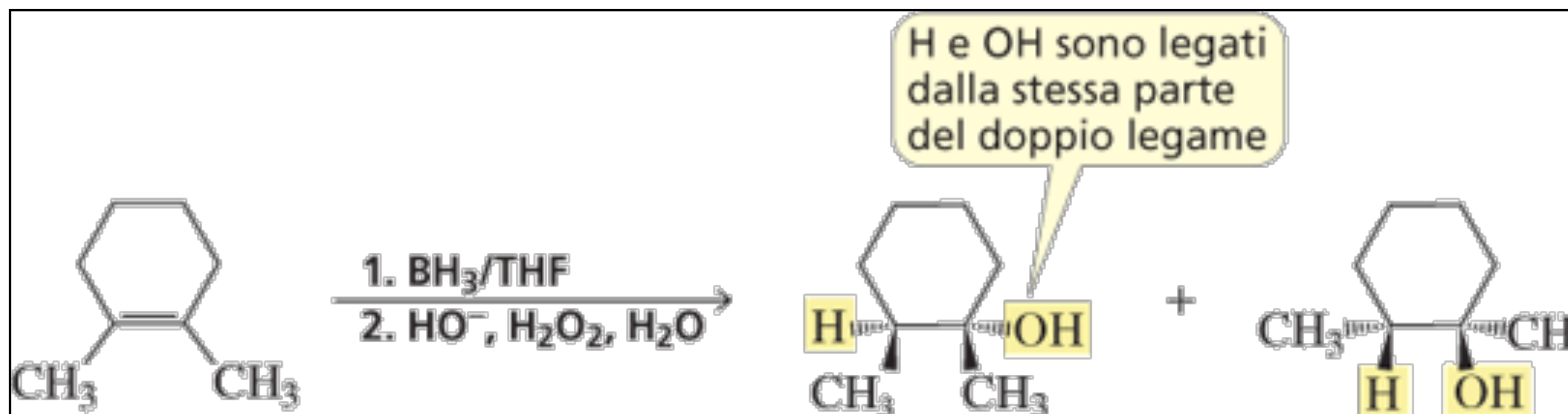




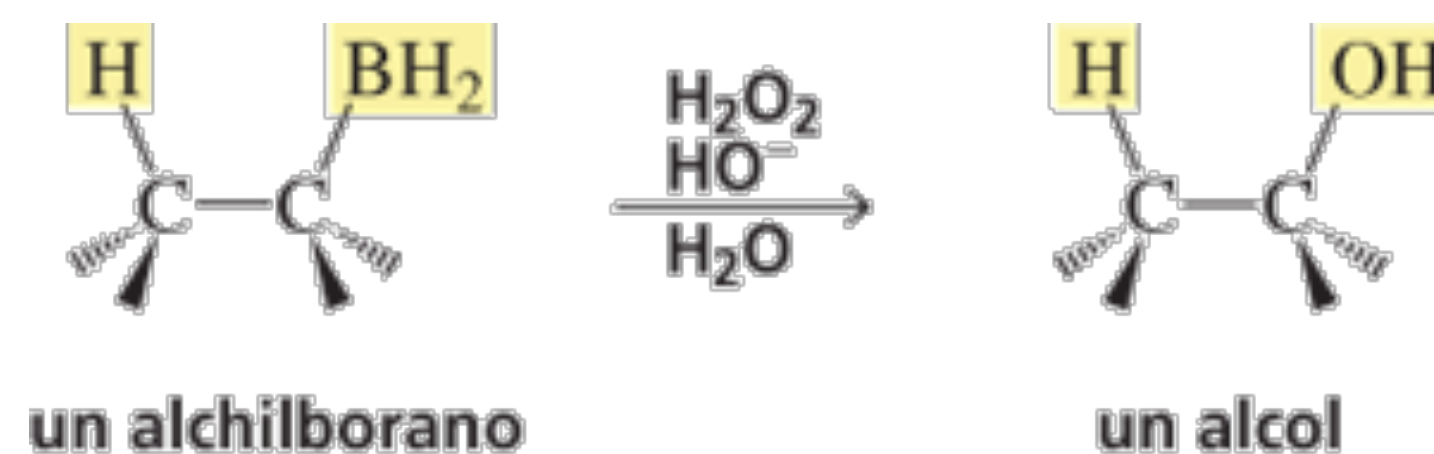
MECCANISMO DELL'IDROBORAZIONE CON R_2BH



Stereochimica della reazione di idrobrazione-ossidazione

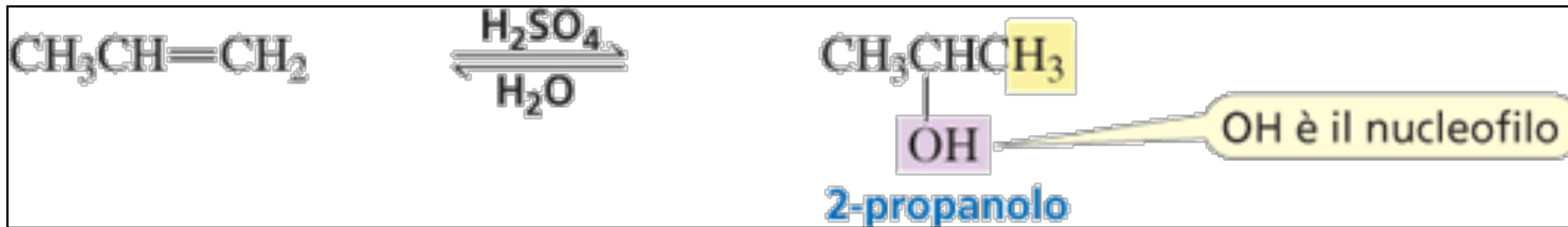


l'addizione di borano è un'addizione sin



l'idrobrazione-ossidazione è nel complesso un'addizione sin di acqua

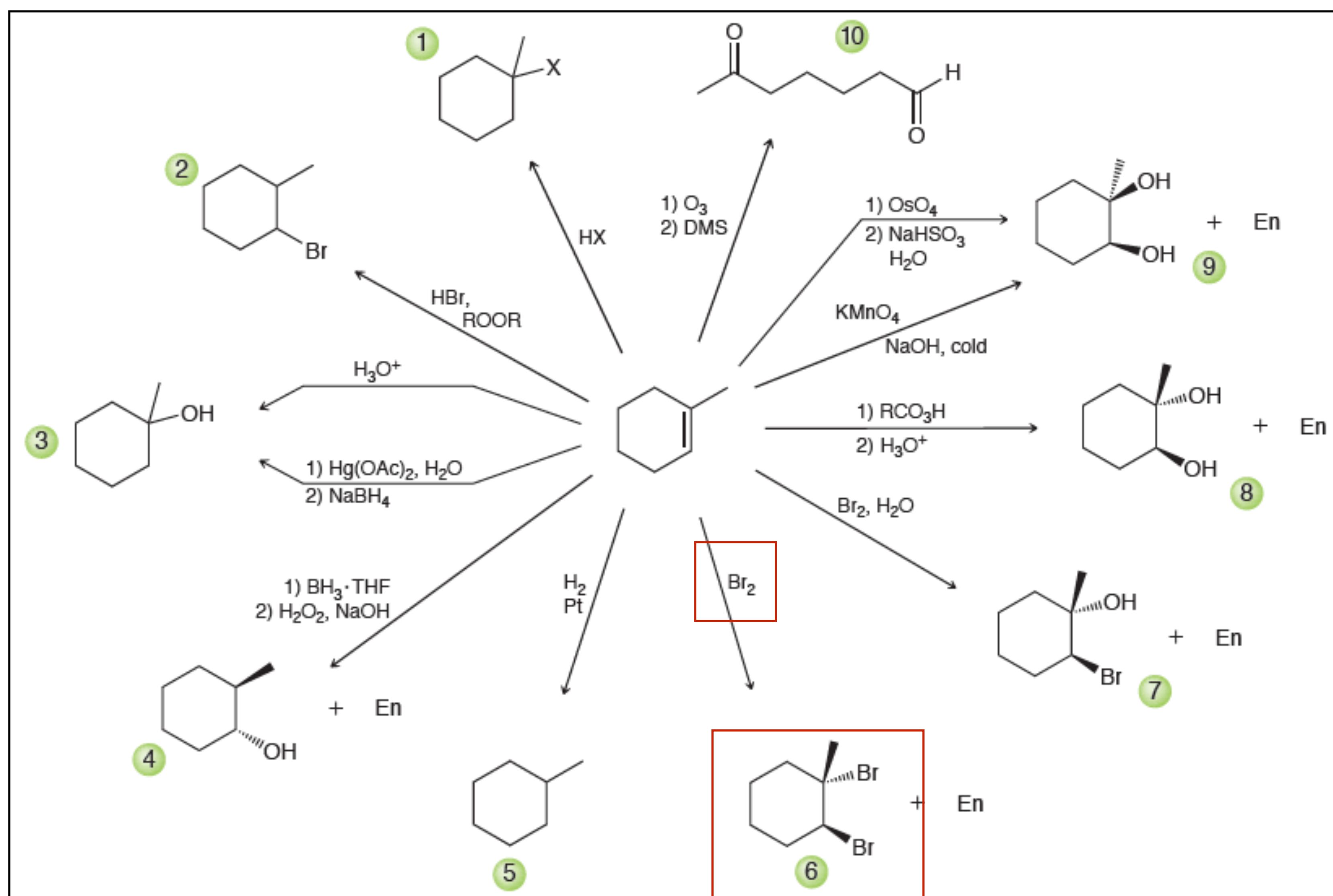
In entrambe le reazioni, l'elettrofilo si lega al carbonio sp² che è legato al maggior numero di idrogeni.



Nell'idratazione catalizzata da acidi, l'elettrofilo è l' H^+ e il nucleofilo è l' H_2O .



Nell'idrobrazione-ossidazione, come vedremo in seguito, BH_3 è l'elettrofilo (successivamente sostituito con OH) e l' H^- è il nucleofilo.



1. Hydrohalogenation (Markovnikov)

4. Hydroboration-oxidation

8. Anti dihydroxylation

2. Hydrohalogenation (anti-Markovnikov)

5. Hydrogenation

9. Syn dihydroxylation

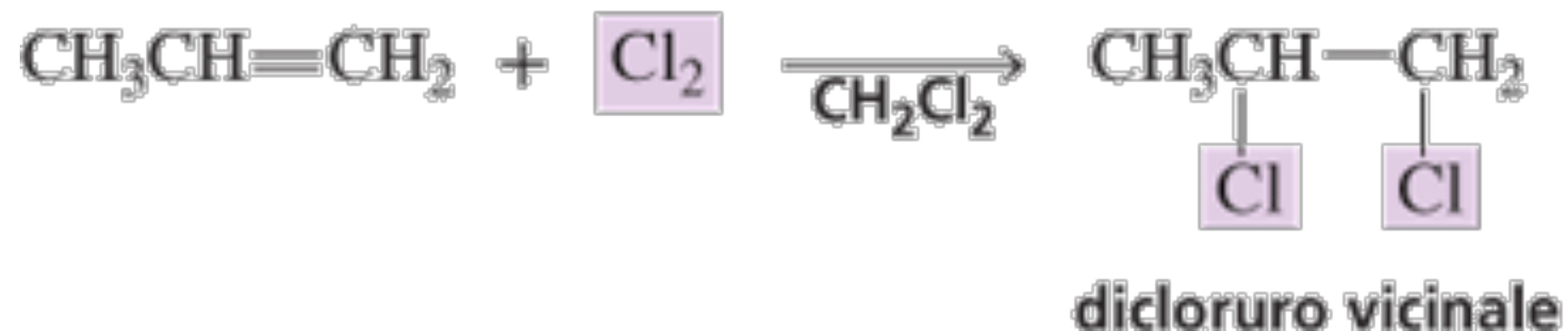
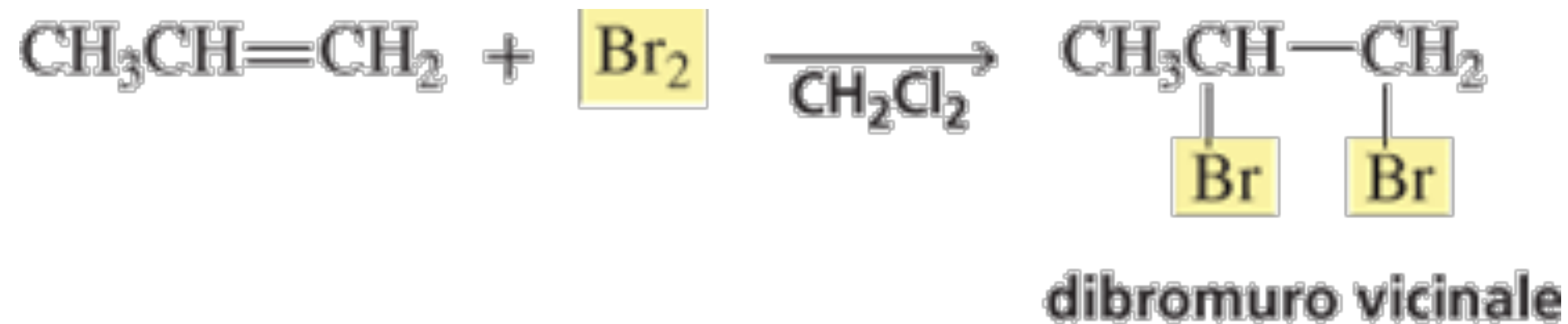
3. Acid-catalyzed hydration and
oxymercuration-demercuration

6. Bromination

10. Ozonolysis

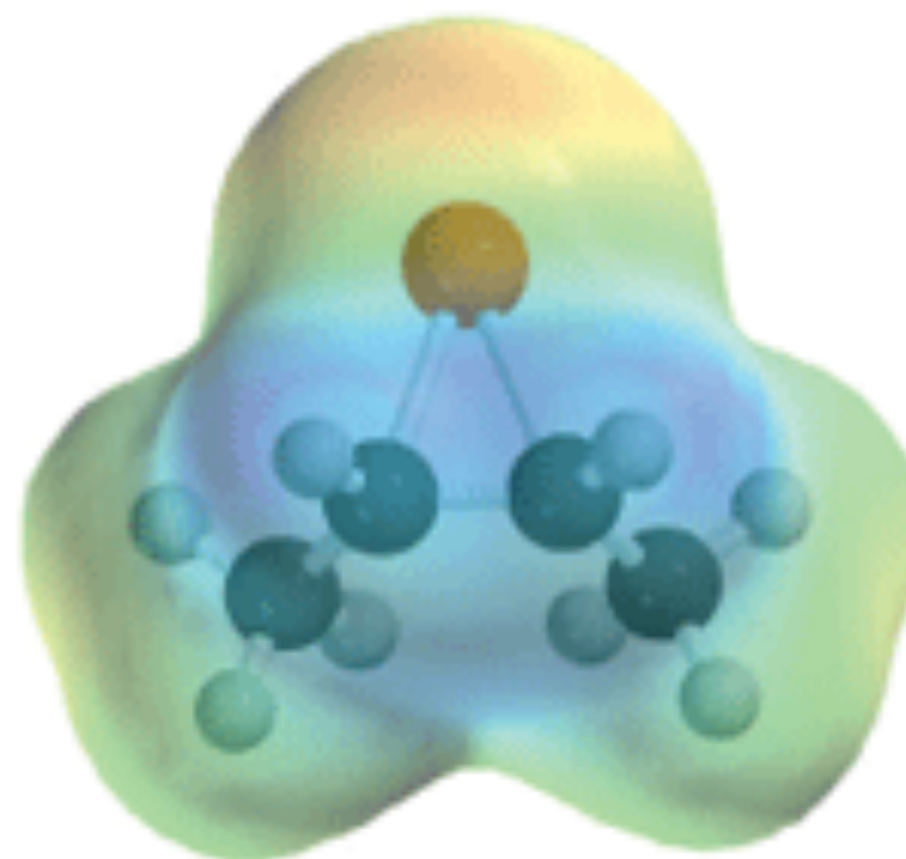
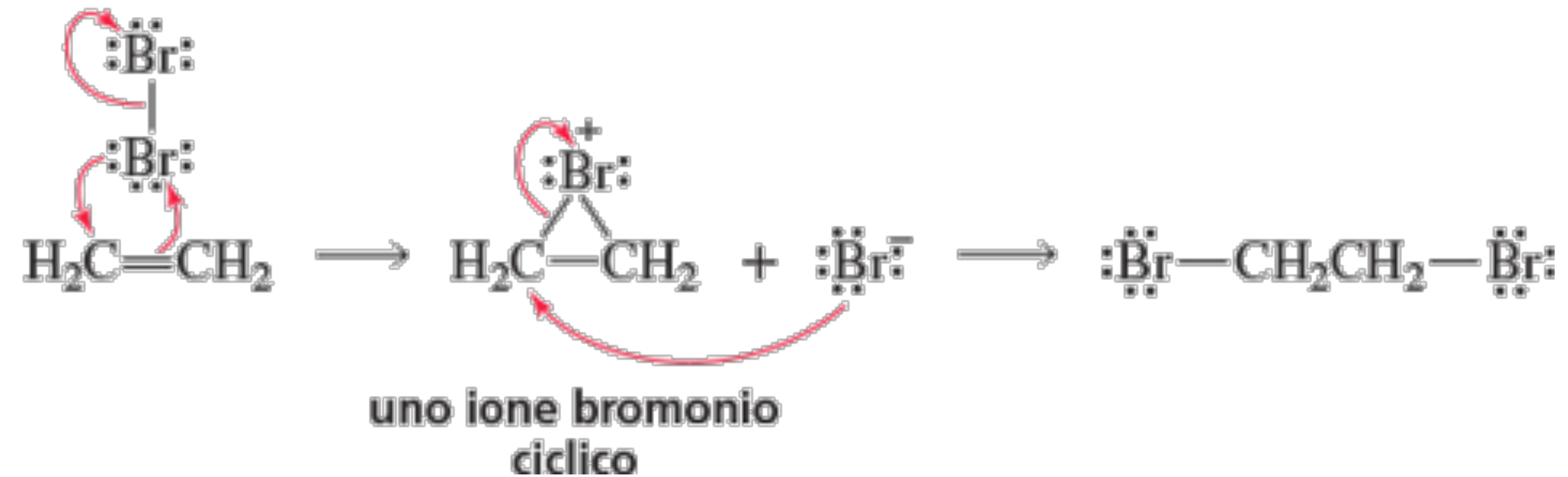
7. Halohydrin formation

ADDIZIONE DI ALOGENI AGLI ALCENI



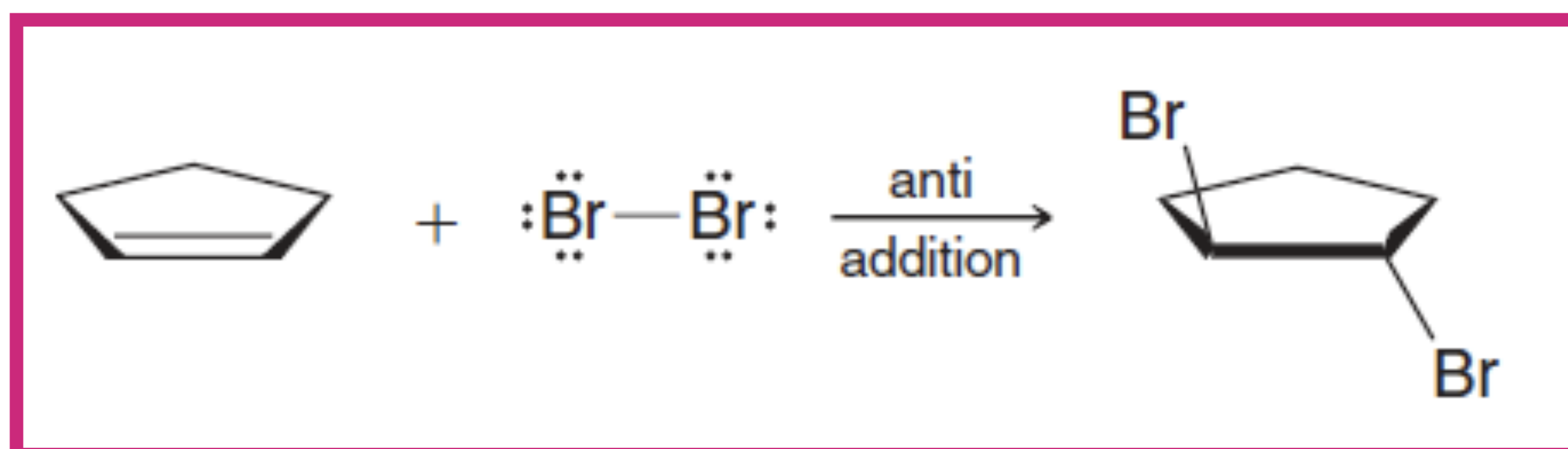
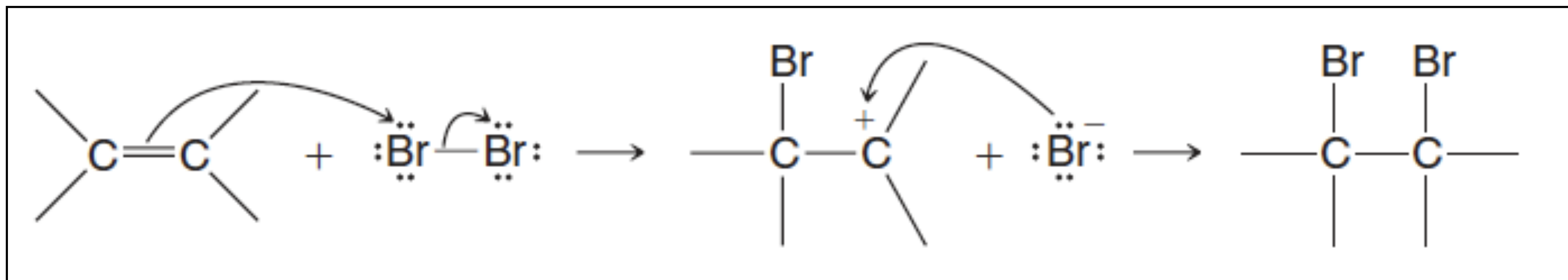
ADDIZIONE DI ALOGENI AGLI ALCHENI

MECCANISMO DELL'ADDIZIONE DI BROMO A UN ALCHENE

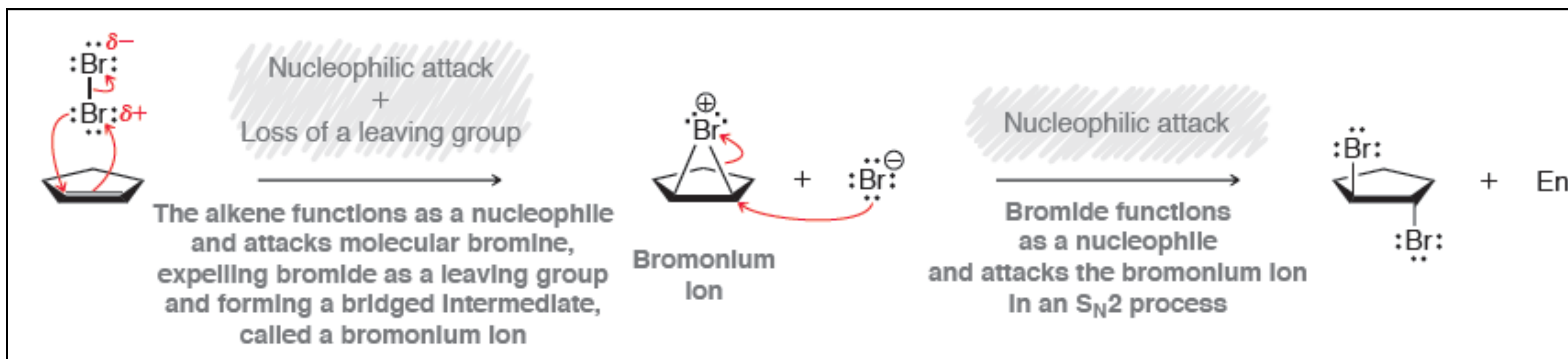


ione bromonio ciclico

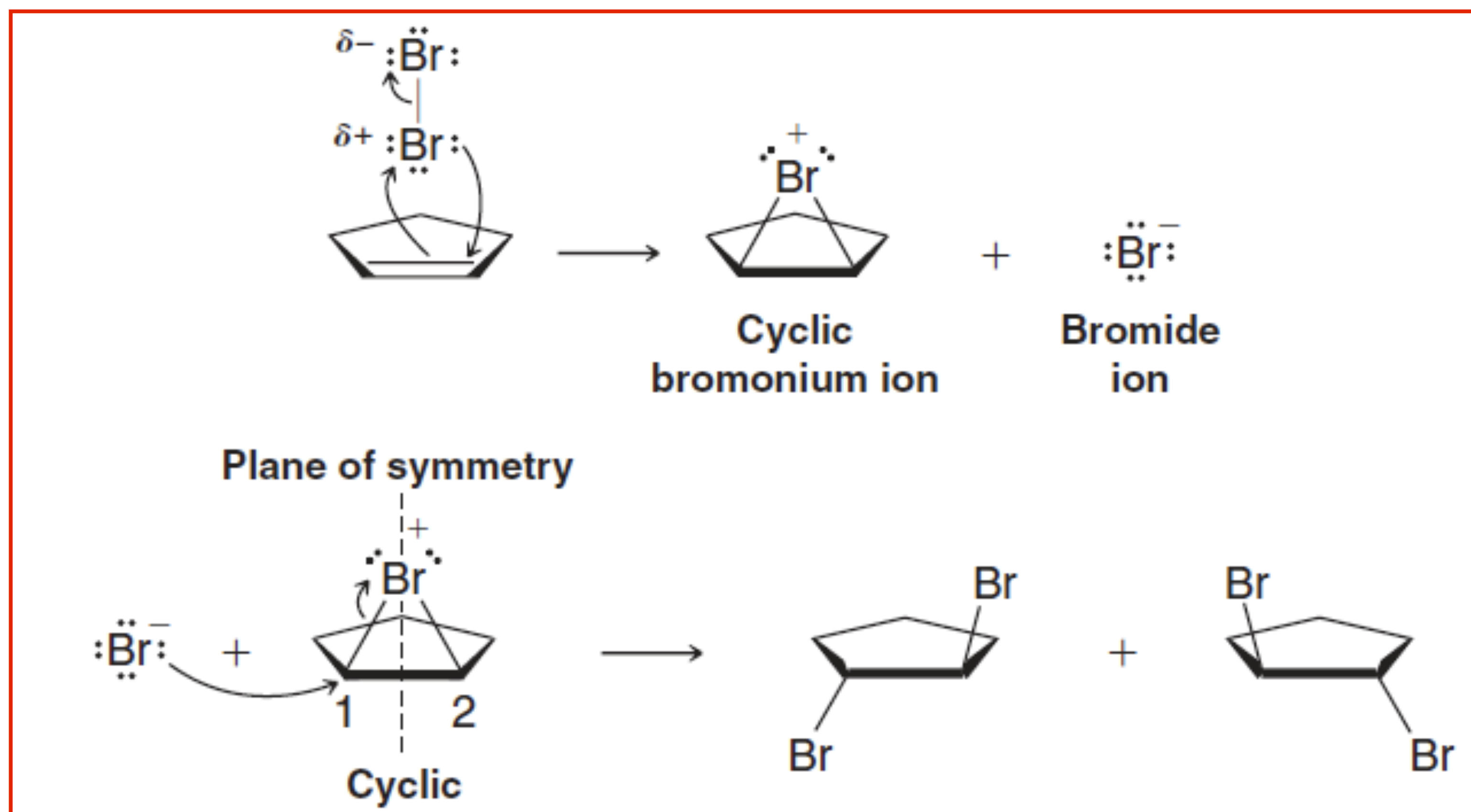
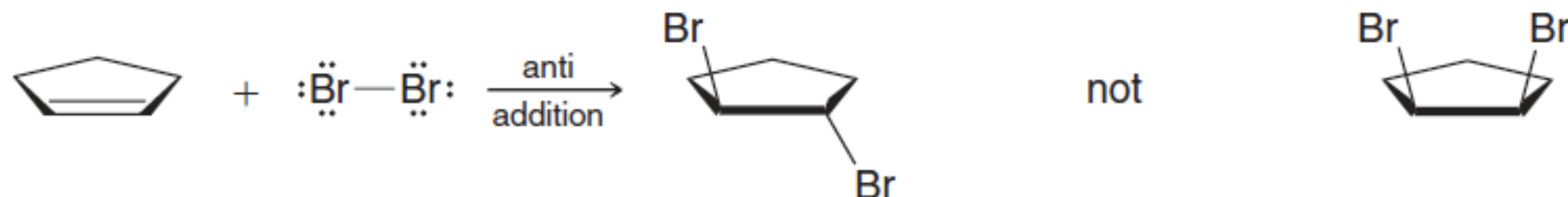
Estereochimica addizione ANTI di Br₂ a un alchene



not



Estereochimica addizione ANTI di Br₂ a un alchene



Addizione di Br₂ al Cis-2-butene

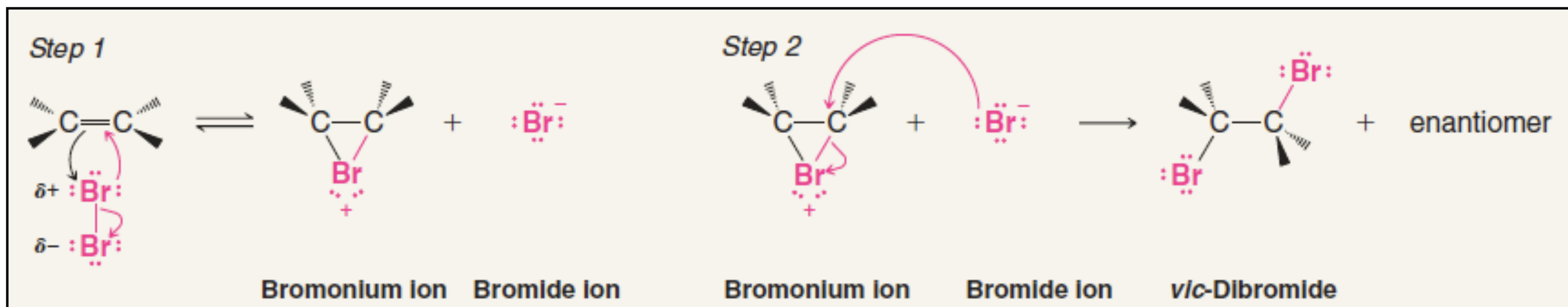
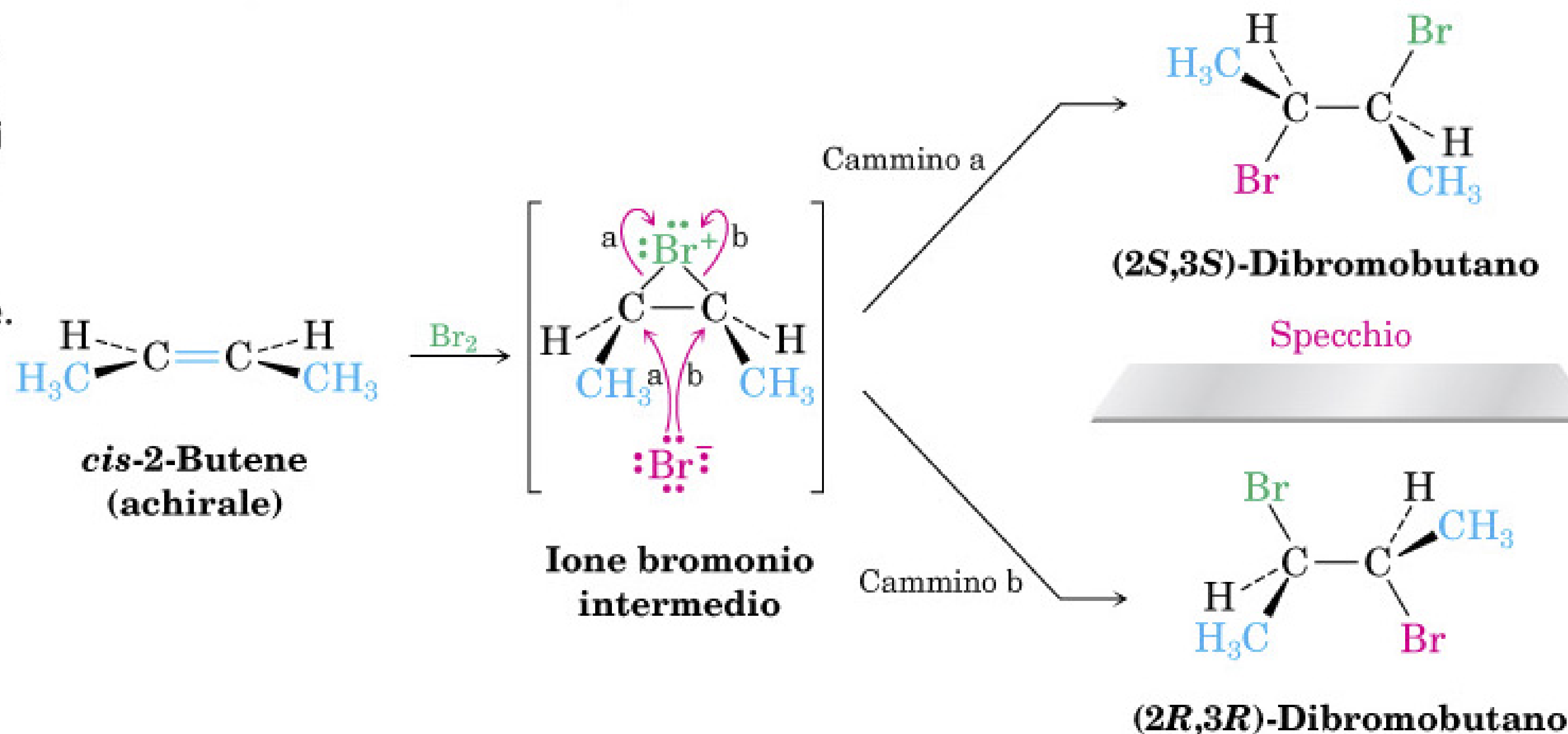
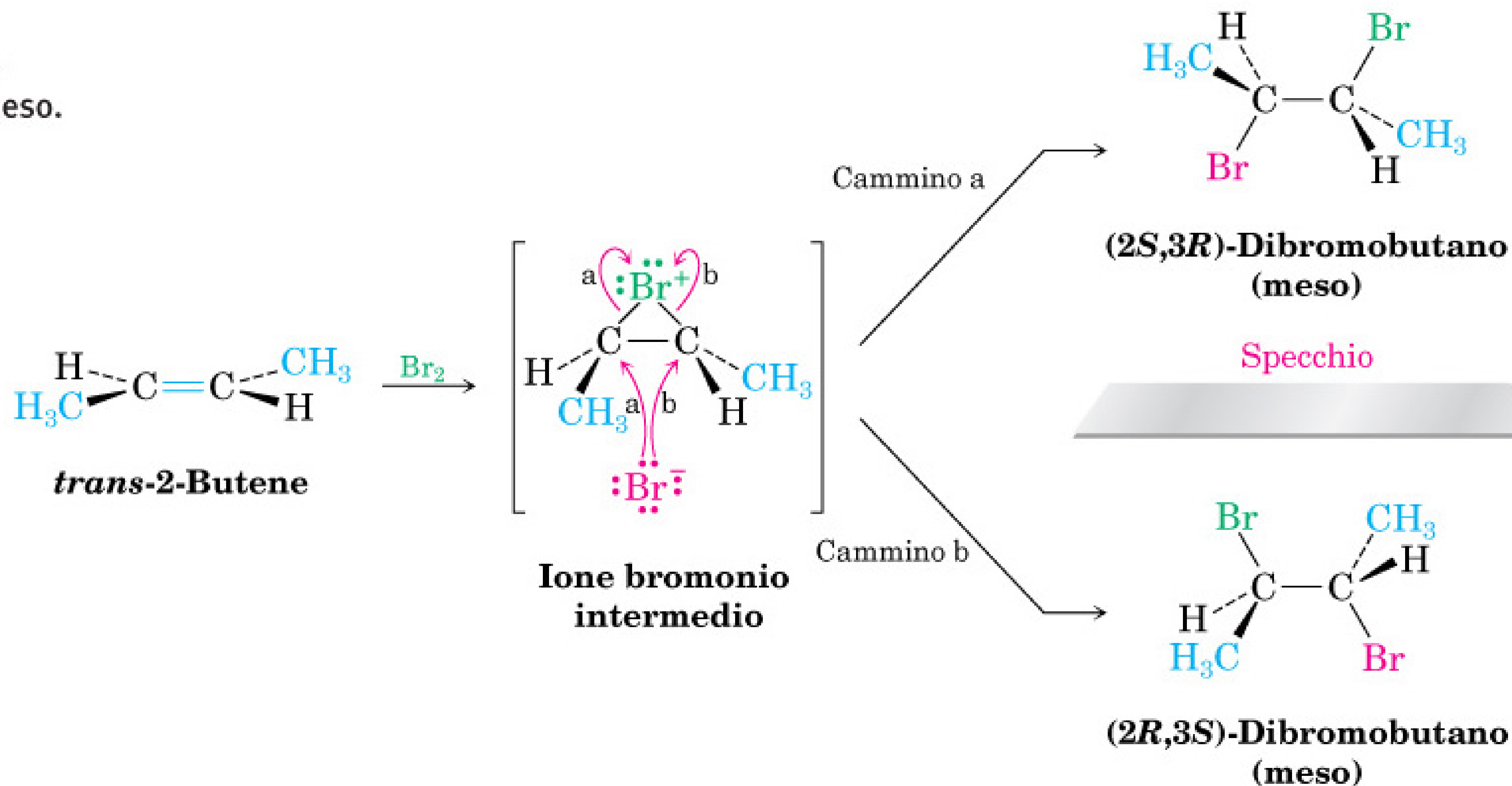


FIGURA 9.16 Stereochimica dell'addizione di Br₂ al *cis*-2-butene. Si forma una miscela racemica dei prodotti 2*S*,3*S* e 2*R*,3*R* perché la reazione di Br⁻ con entrambi gli atomi di carbonio dello ione bromonio è ugualmente probabile.



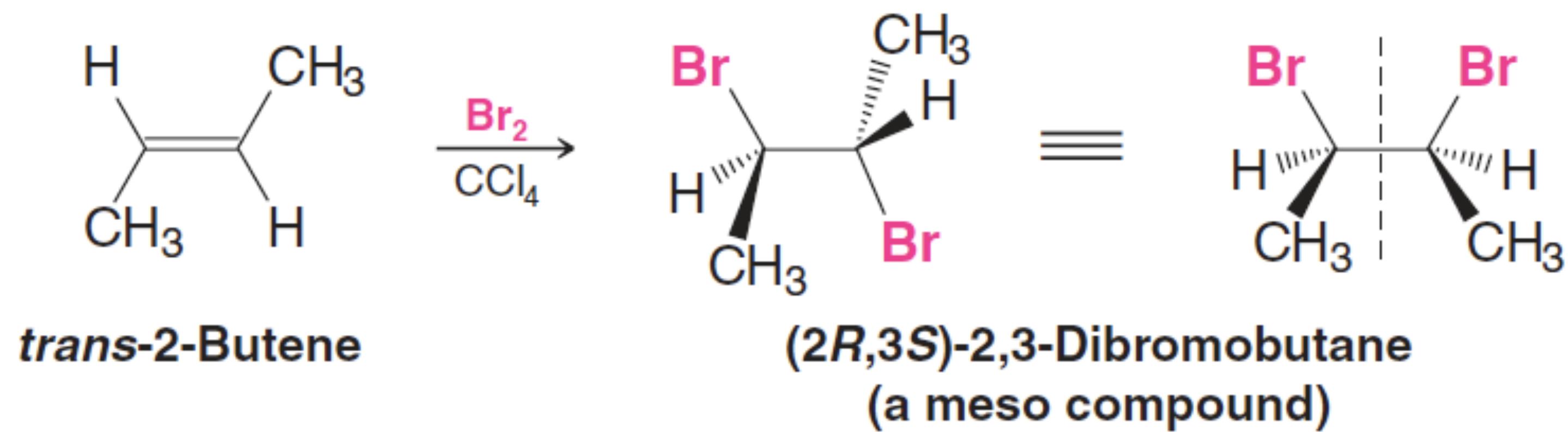
Stereochimica dell'Addizione di Br₂ al *trans*-2-butene

FIGURA 9.17 Stereochimica dell'addizione di Br₂ al *trans*-2-butene. Si forma un prodotto meso.

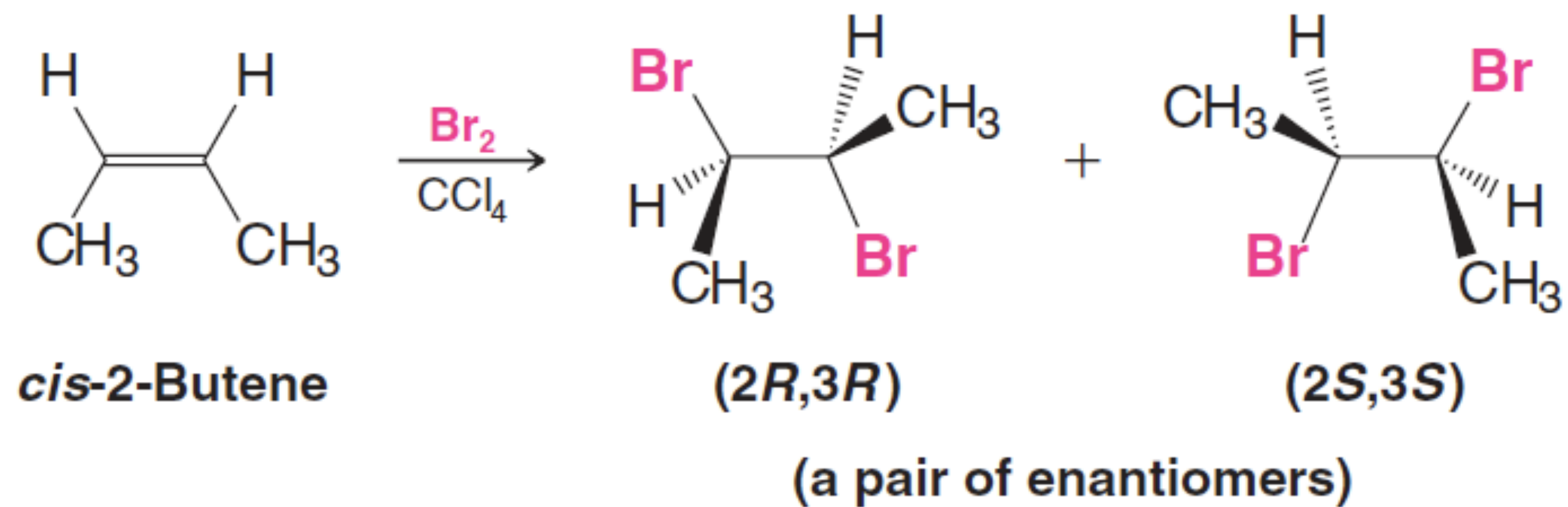


Reazioni stereospecifiche

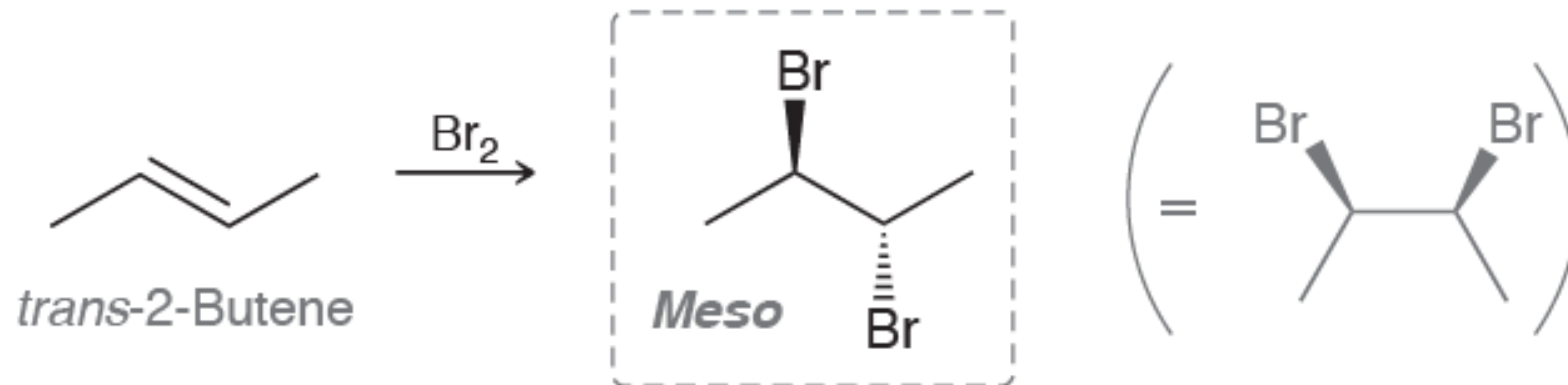
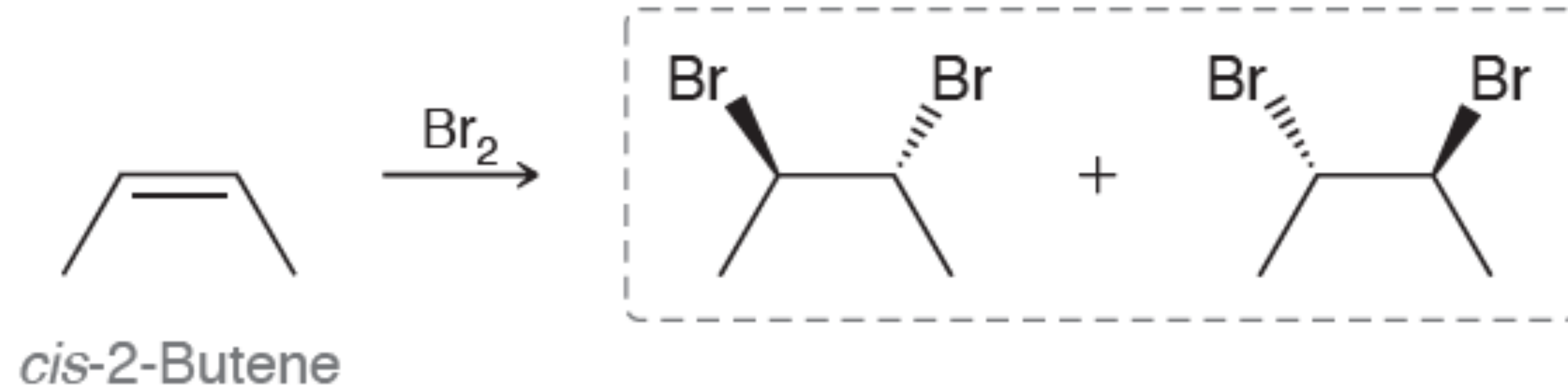
Reaction 1



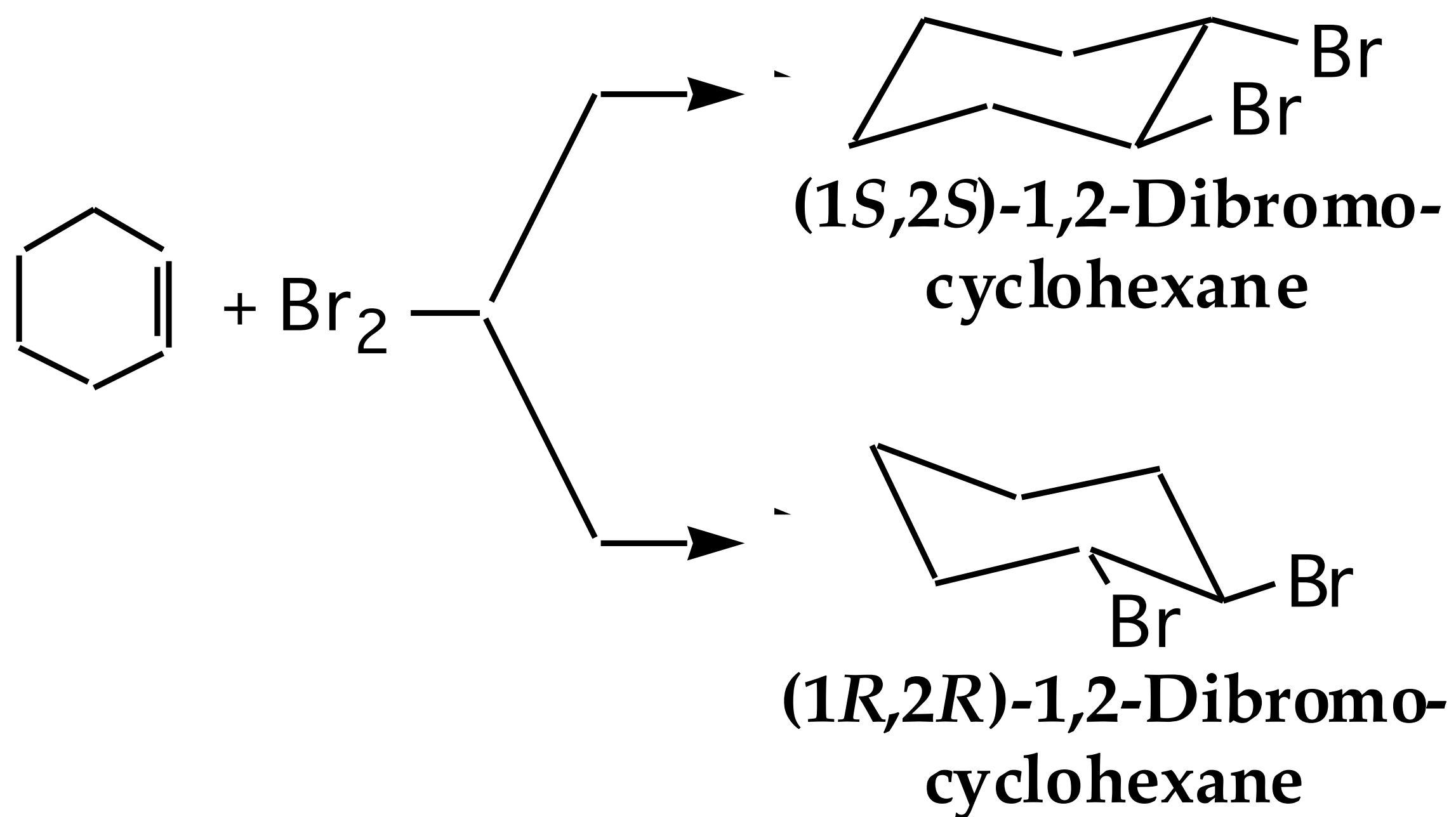
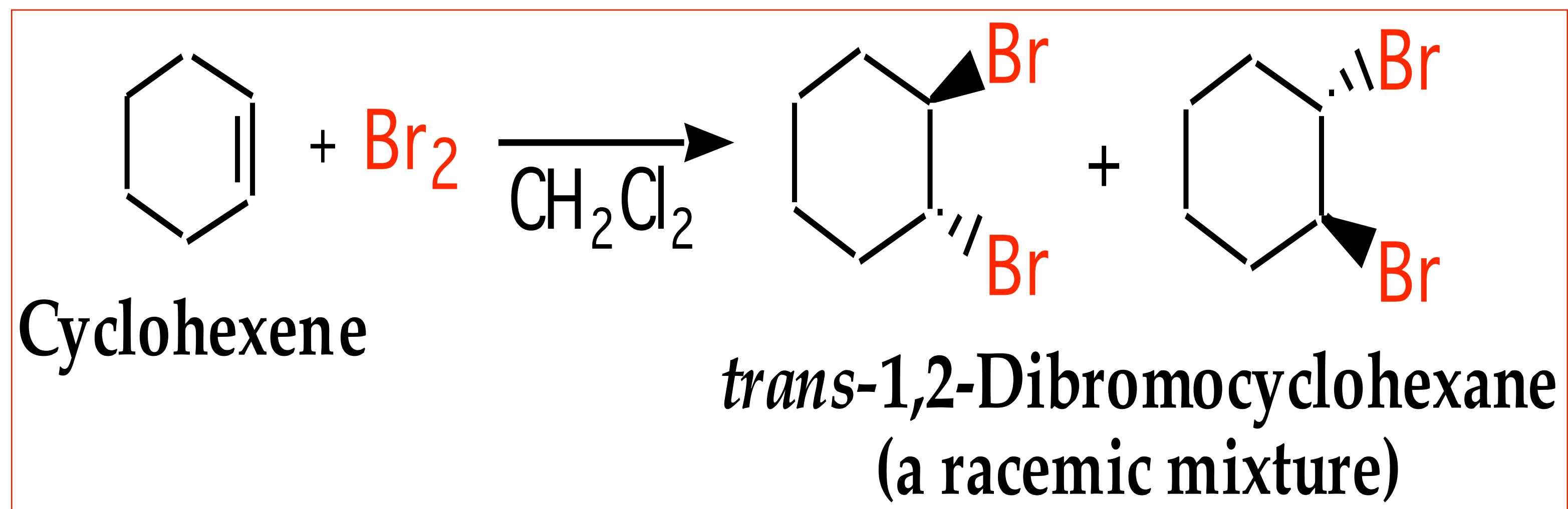
Reaction 2

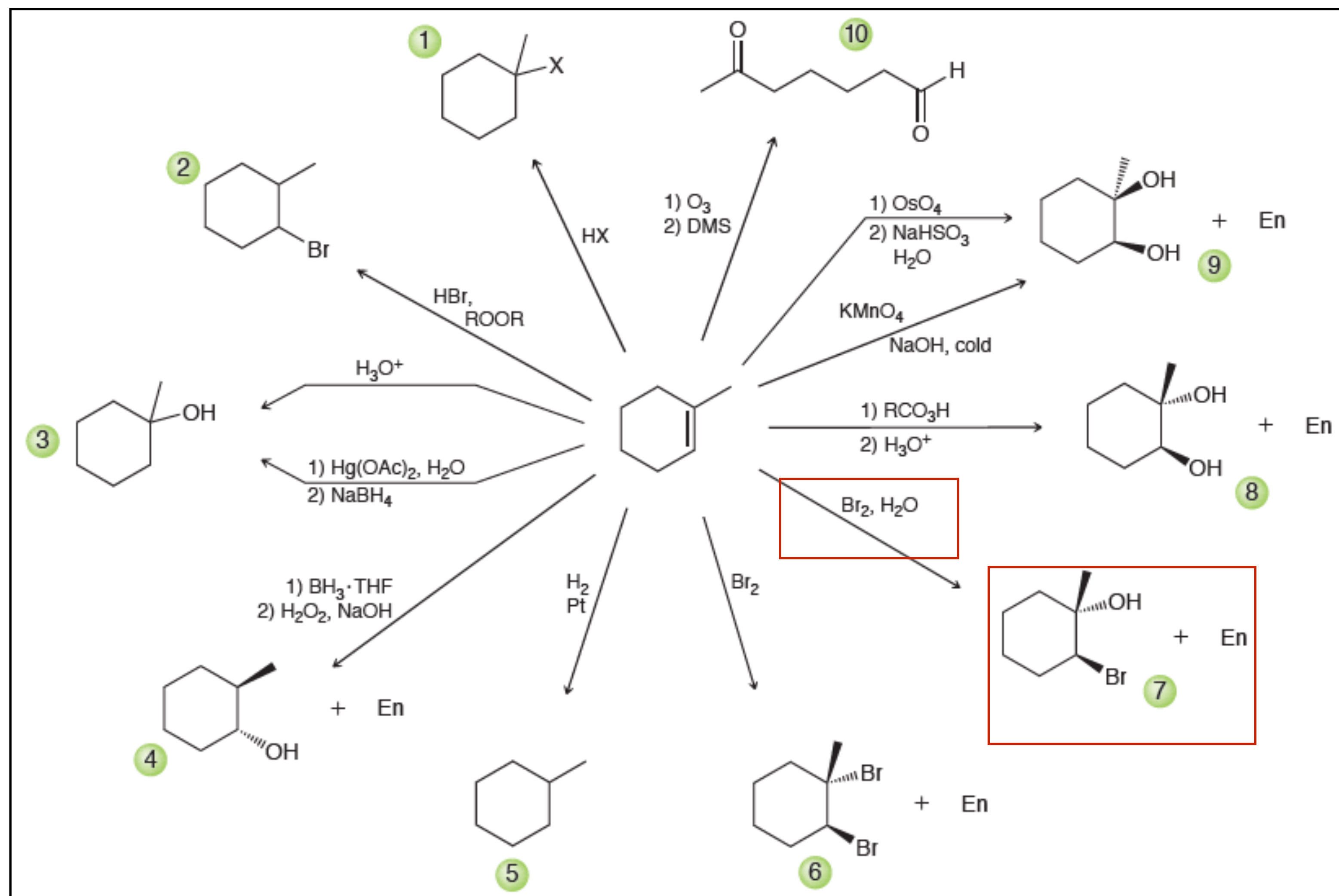


Reazioni stereospecifiche



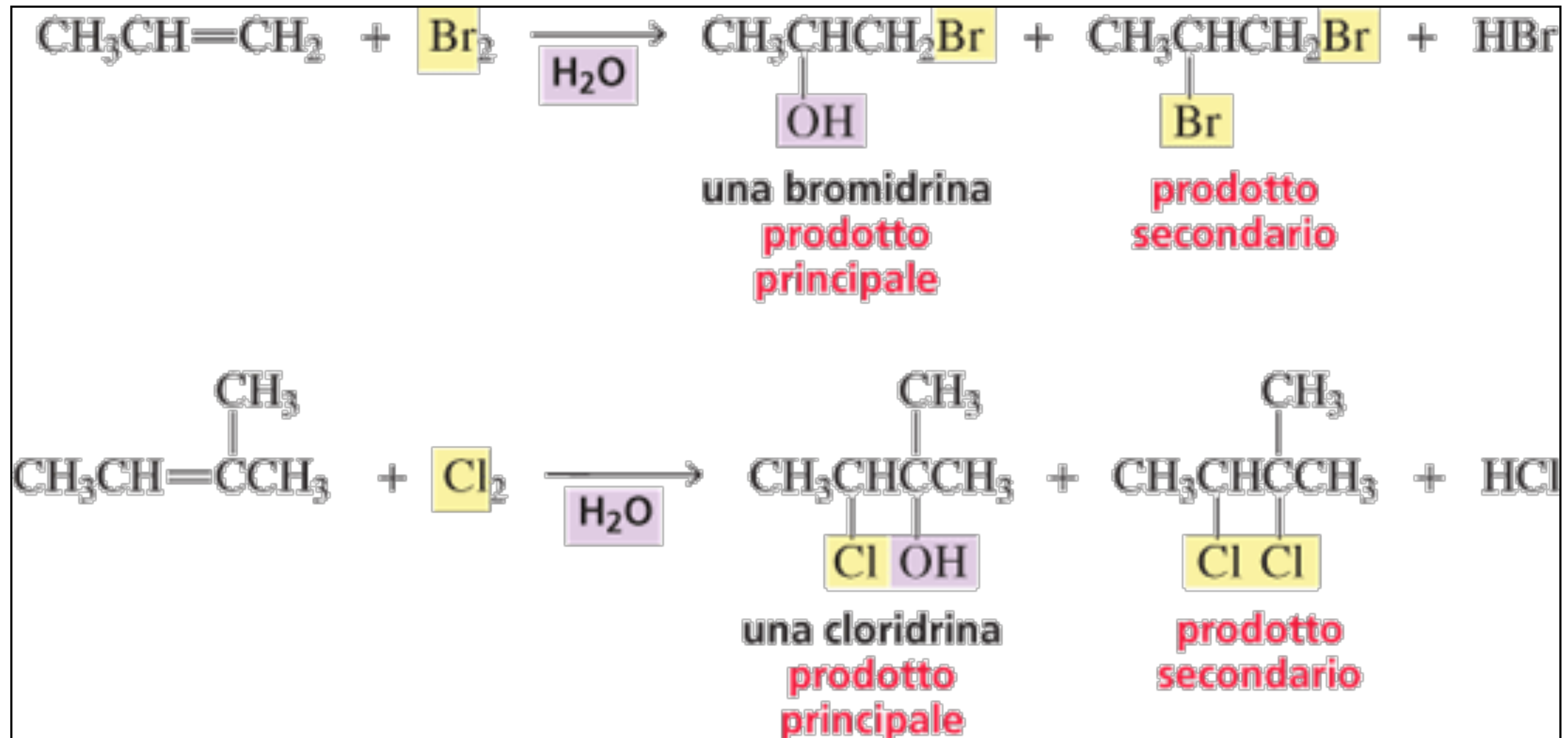
Reazioni stereospecifiche



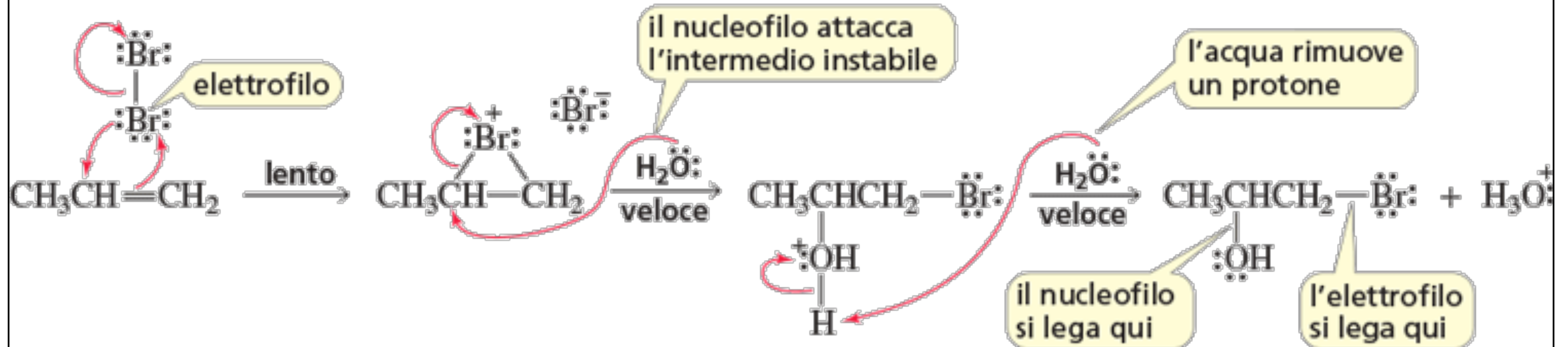


- | | | |
|--|----------------------------|-------------------------|
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| | 7. Halohydrin formation | |

Nucleofili competitivi: Formazione di Alodrine

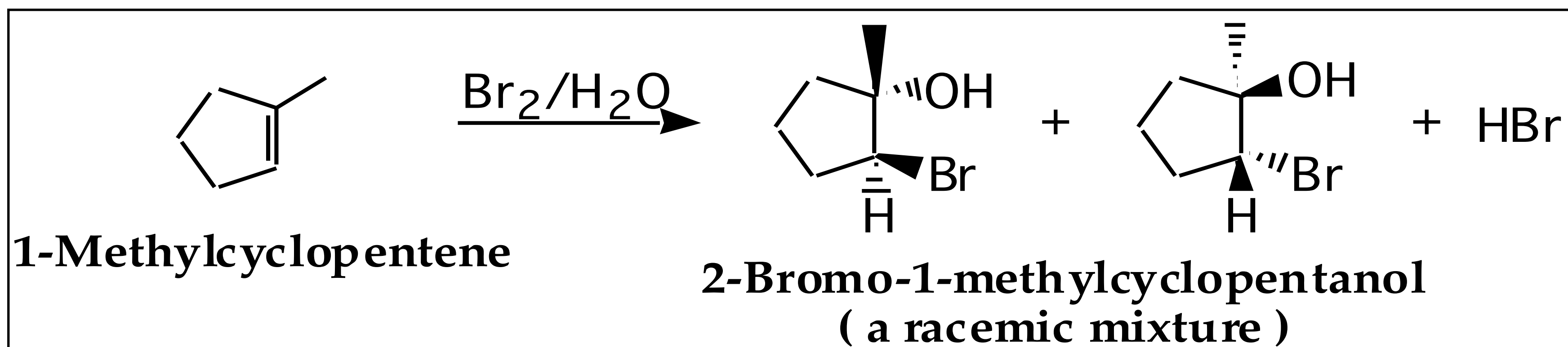
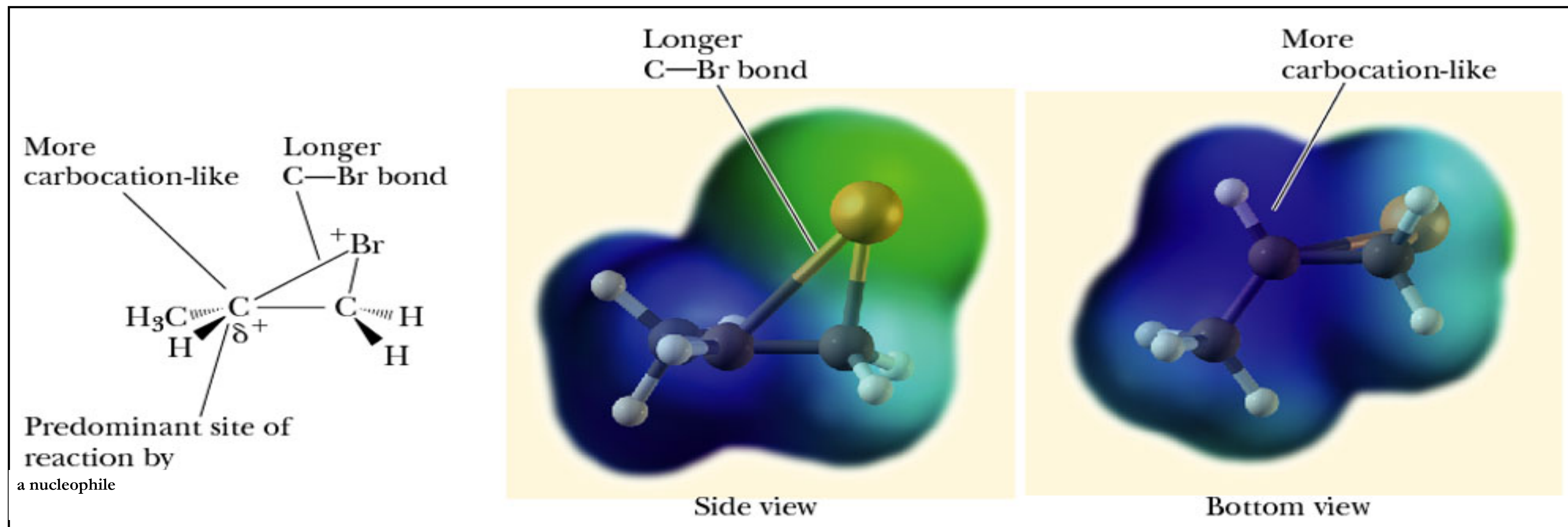


MECCANISMO DELLA FORMAZIONE DI ALOIDRINA

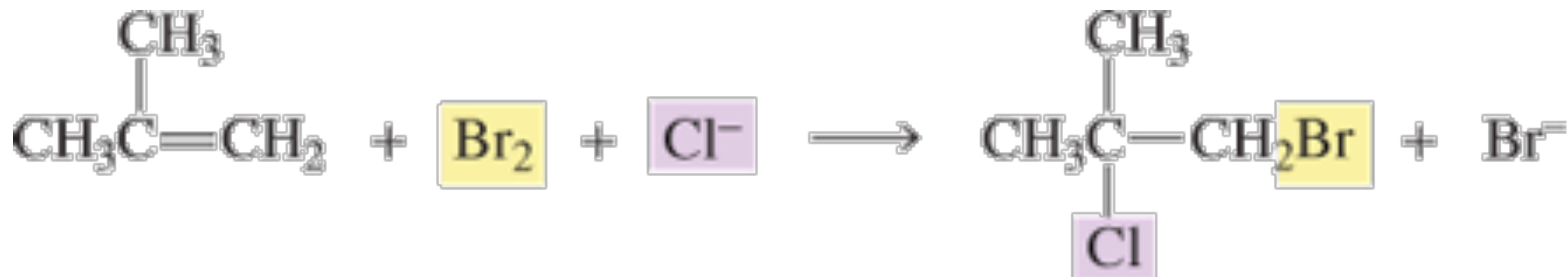
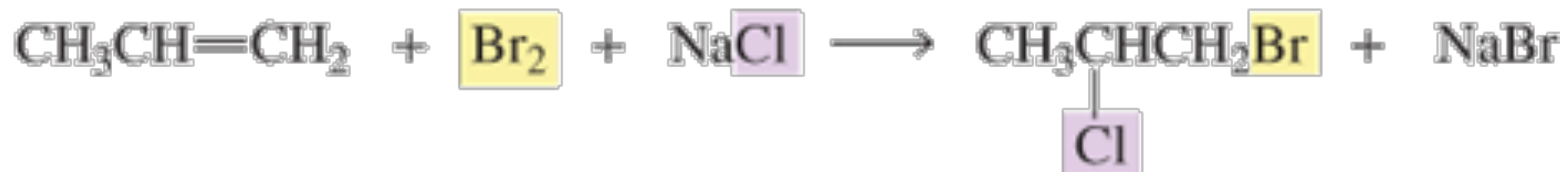
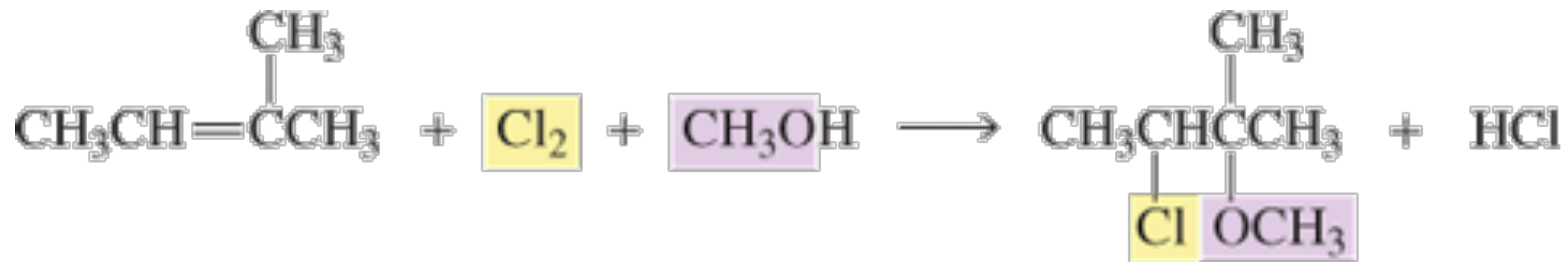


Anche questa reazione, dunque, segue la regola generale delle reazioni di addizione elettrofila: l'elettrofilo (in questo caso Br^+) si lega al carbonio sp^2 che è legato al maggior numero di idrogeni, mentre il nucleofilo (H_2O) si lega all'altro carbonio sp^2 .

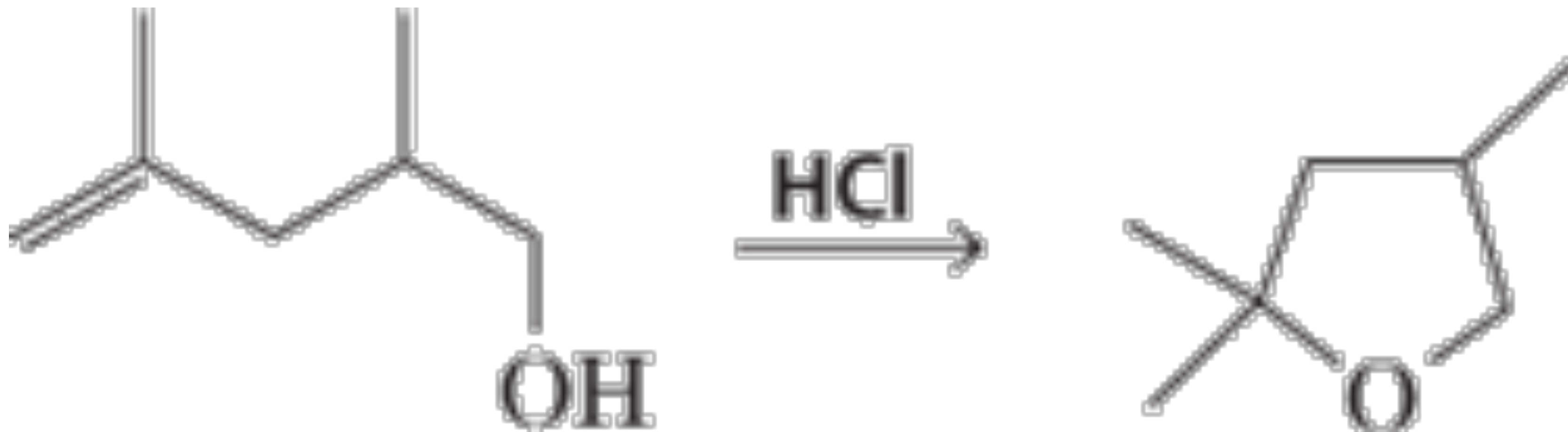
- Addizione *de* H_2O e Br (*reazione REGIOSSELETTIVA*)



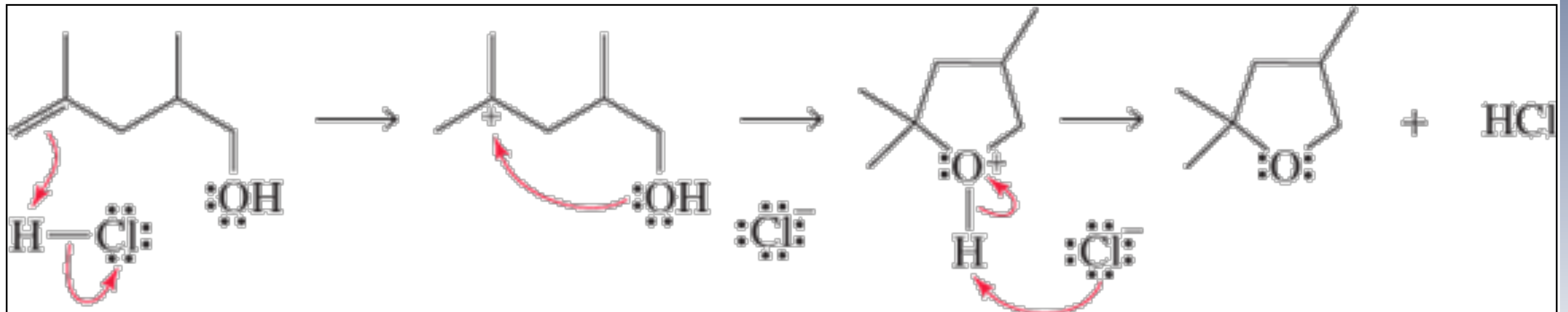
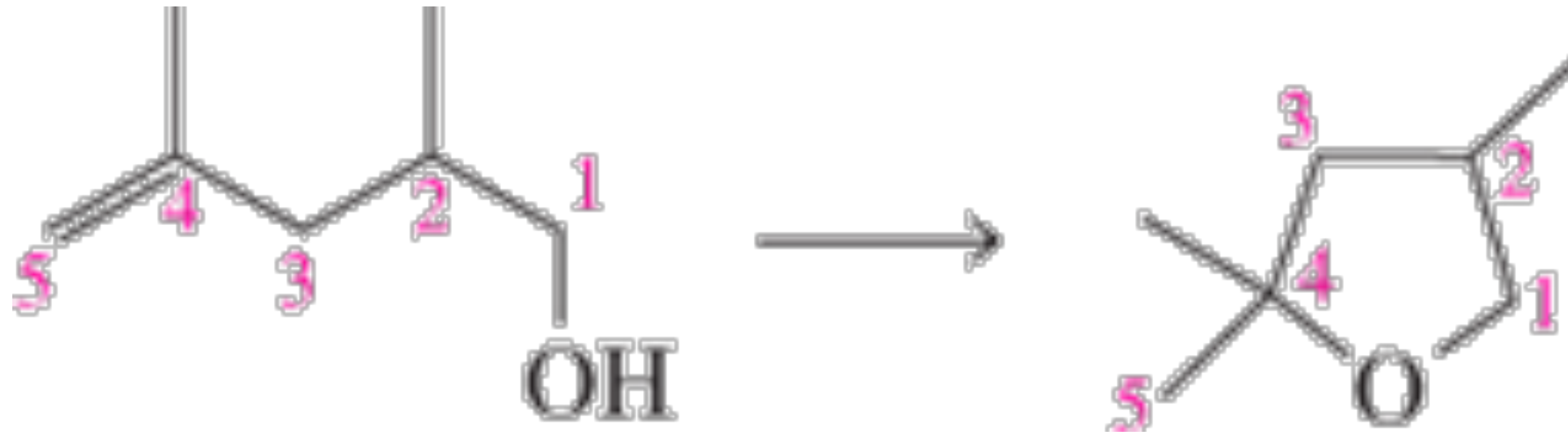
Nucleofili competitivi



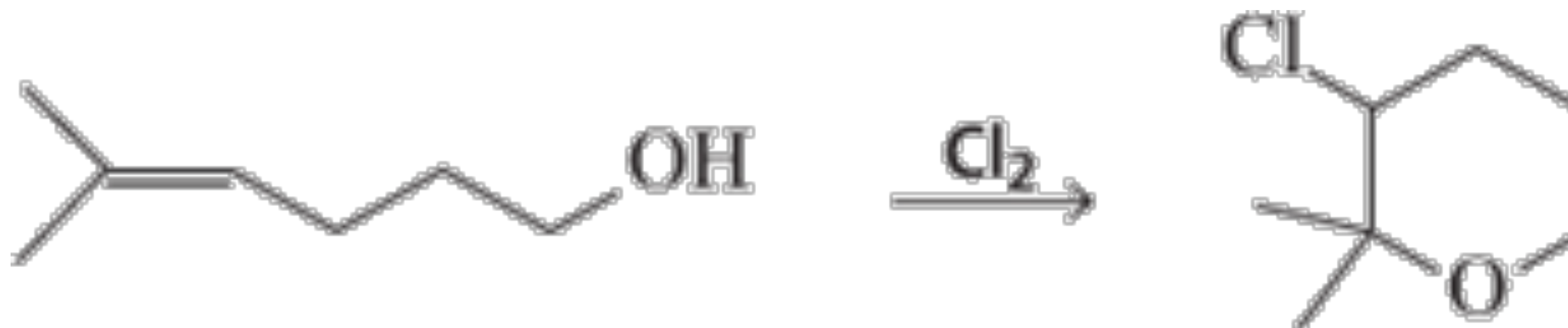
Proporre un meccanismo
Proponi un meccanismo per la seguente reazione:



Proporre un meccanismo
 Proponi un meccanismo per la seguente reazione:

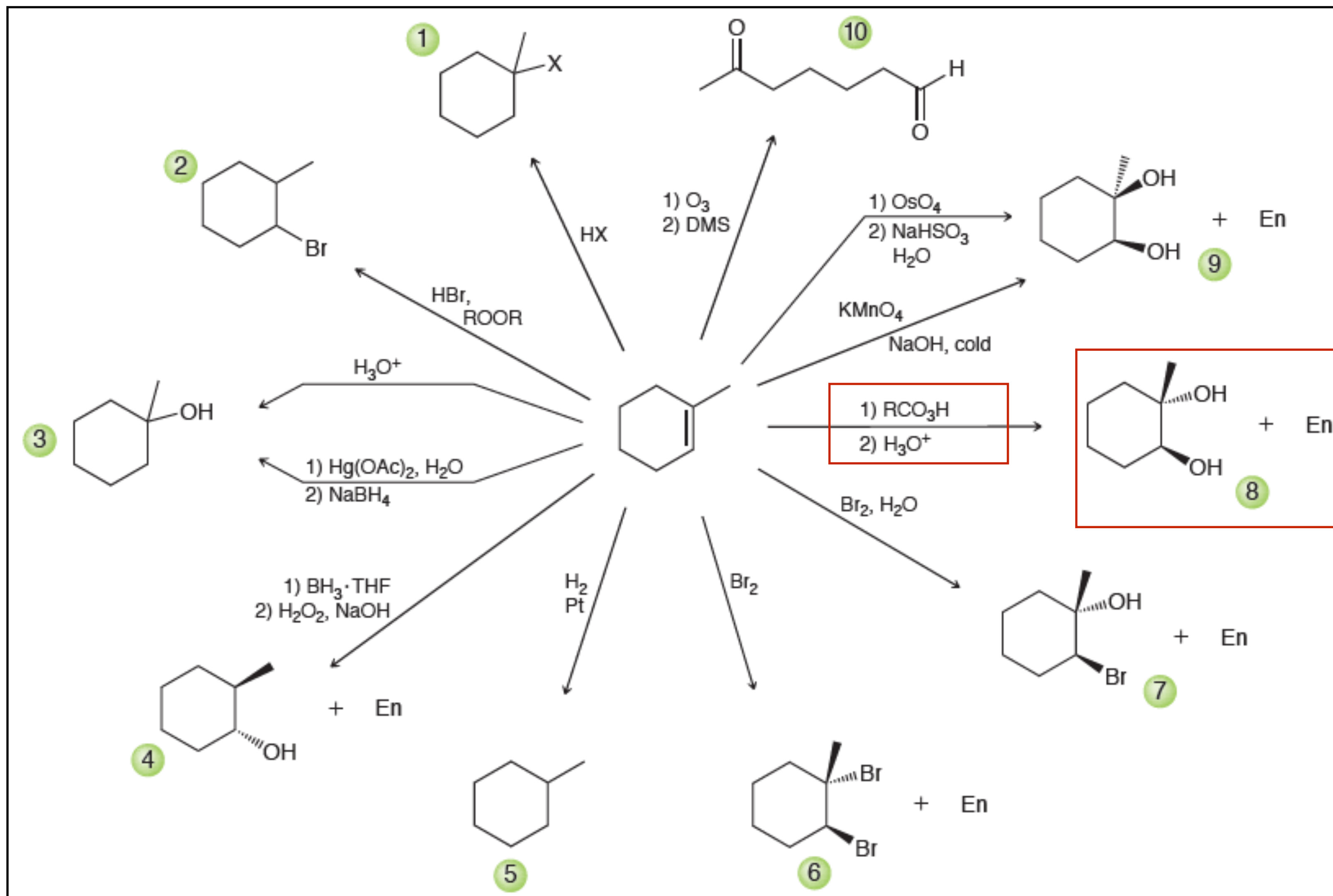


Proponi un meccanismo per la seguente reazione:



OSSIDAZIONE DEGLI ALCENI:

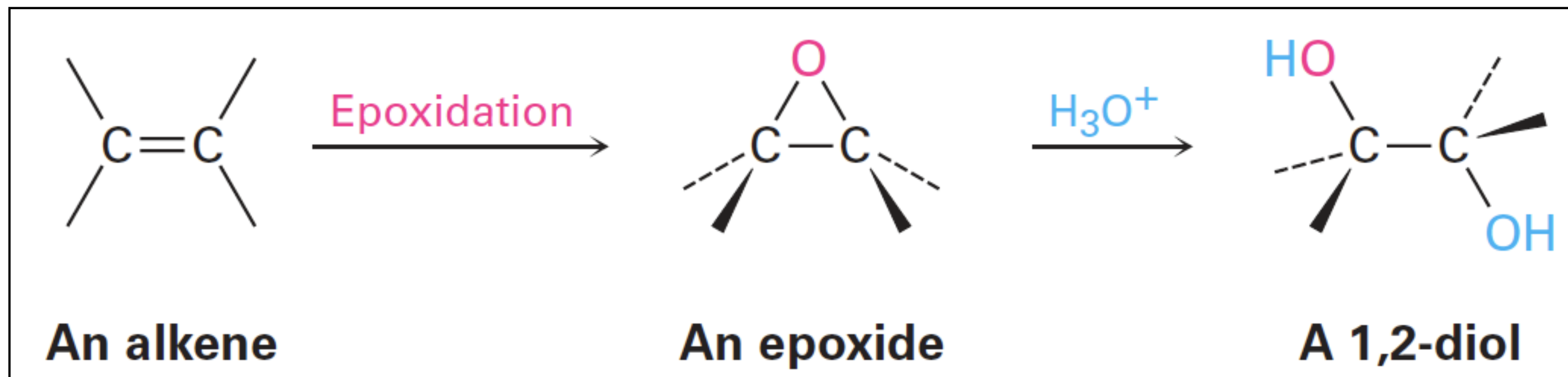
- 1. EPOSSIDAZIONE**
- 2. IDROSSILAZIONE (FORMAZIONE DI DIOLI CIS)**
- 3. OZONOLISI (SCISSIONE OSSIDATIVA DEL DOPPIO LEGAME)**



- | | | |
|--|----------------------------|-------------------------|
| 1. Hydrohalogenation (Markovnikov) | 4. Hydroboration-oxidation | 8. Anti dihydroxylation |
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| | 7. Halohydrin formation | |

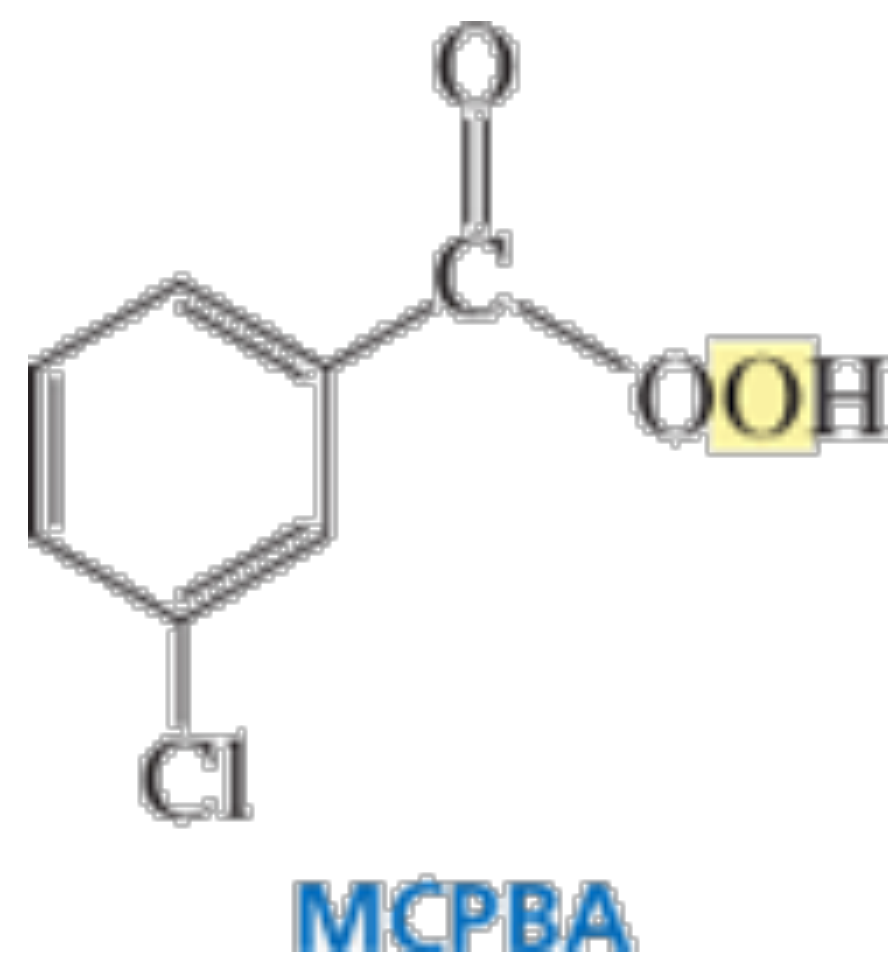
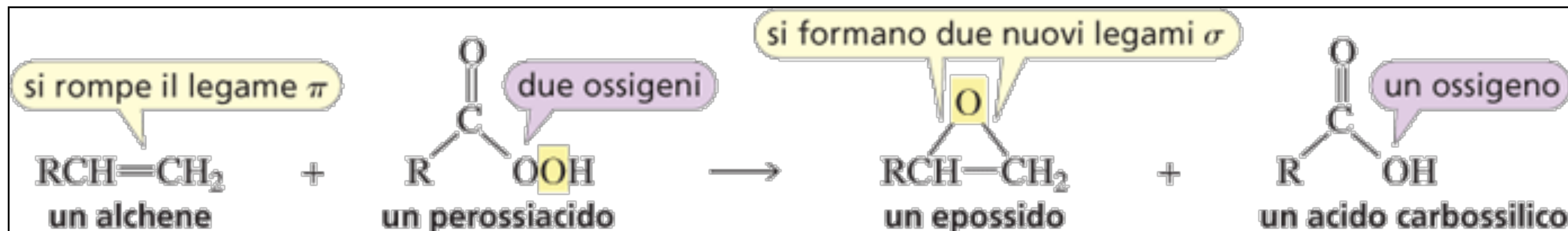
OSSIDAZIONE DEGLI ALCENI:

1. EPOSSIDAZIONE E IDROLISI DELL'EPOSSIDO (FORMAZIONE DI 1,2-DIOLO TRANS)



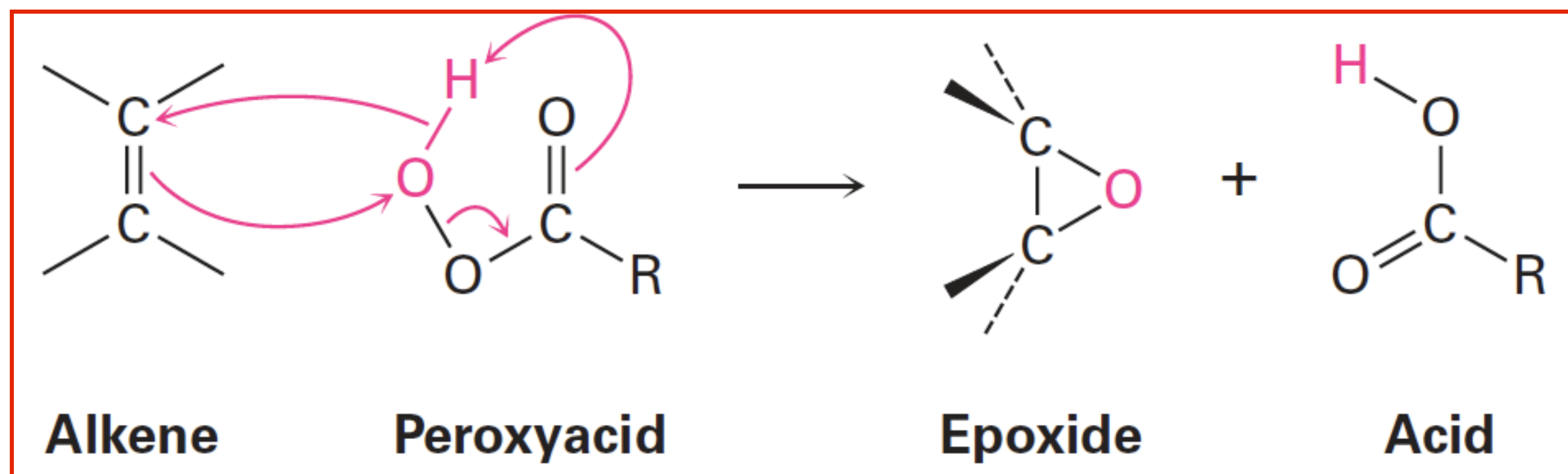
ADDIZIONE DI UN PEROSSIACIDO AGLI ALCHENI

Un alchene può essere convertito in un epossido mediante un perossiacido.



Il perossiacido comunemente impiegato per l'epossidazione è l'MCPBA (acido meta-cloroperossibenzoico).

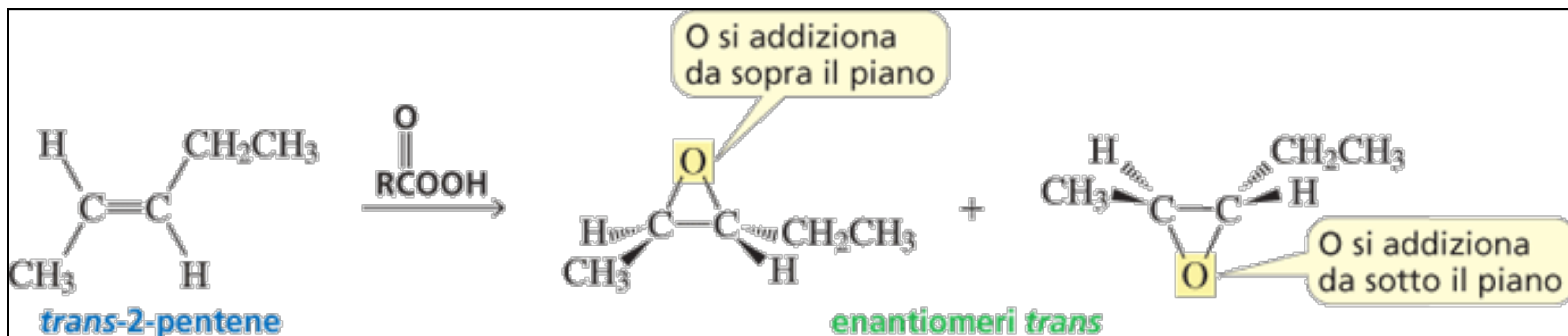
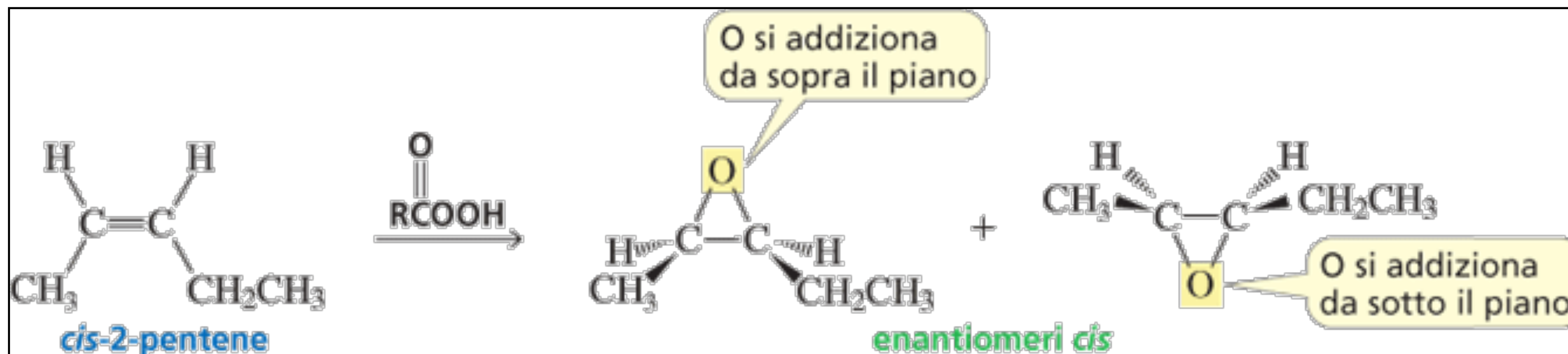
MECCANISMO DELLA EPOSSIDAZIONE DI UN ALCHENE



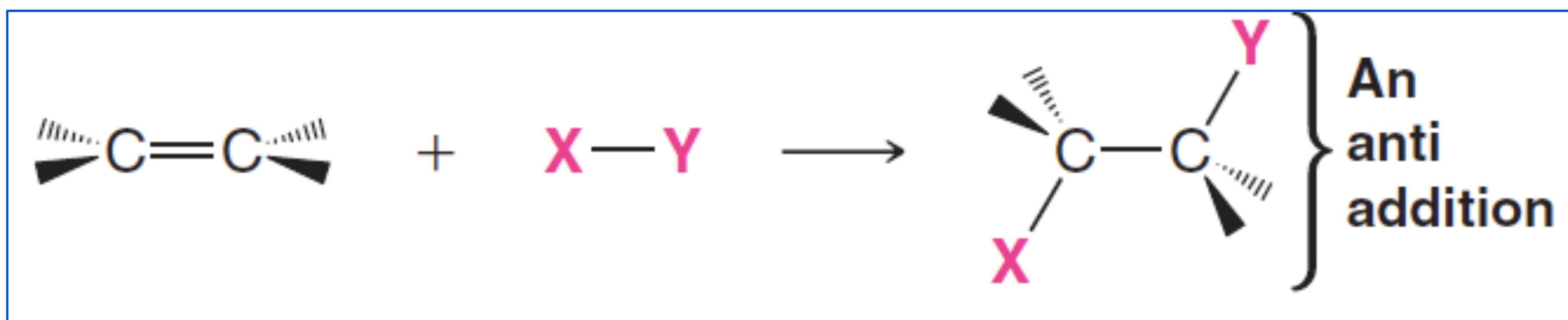
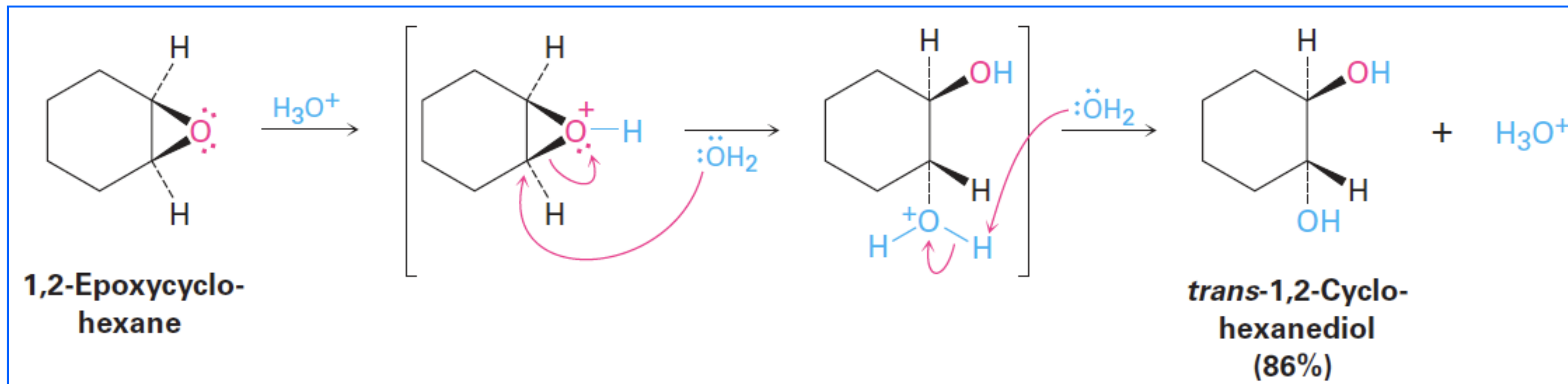
Stereochimica della reazione di addizione di perossiacidi

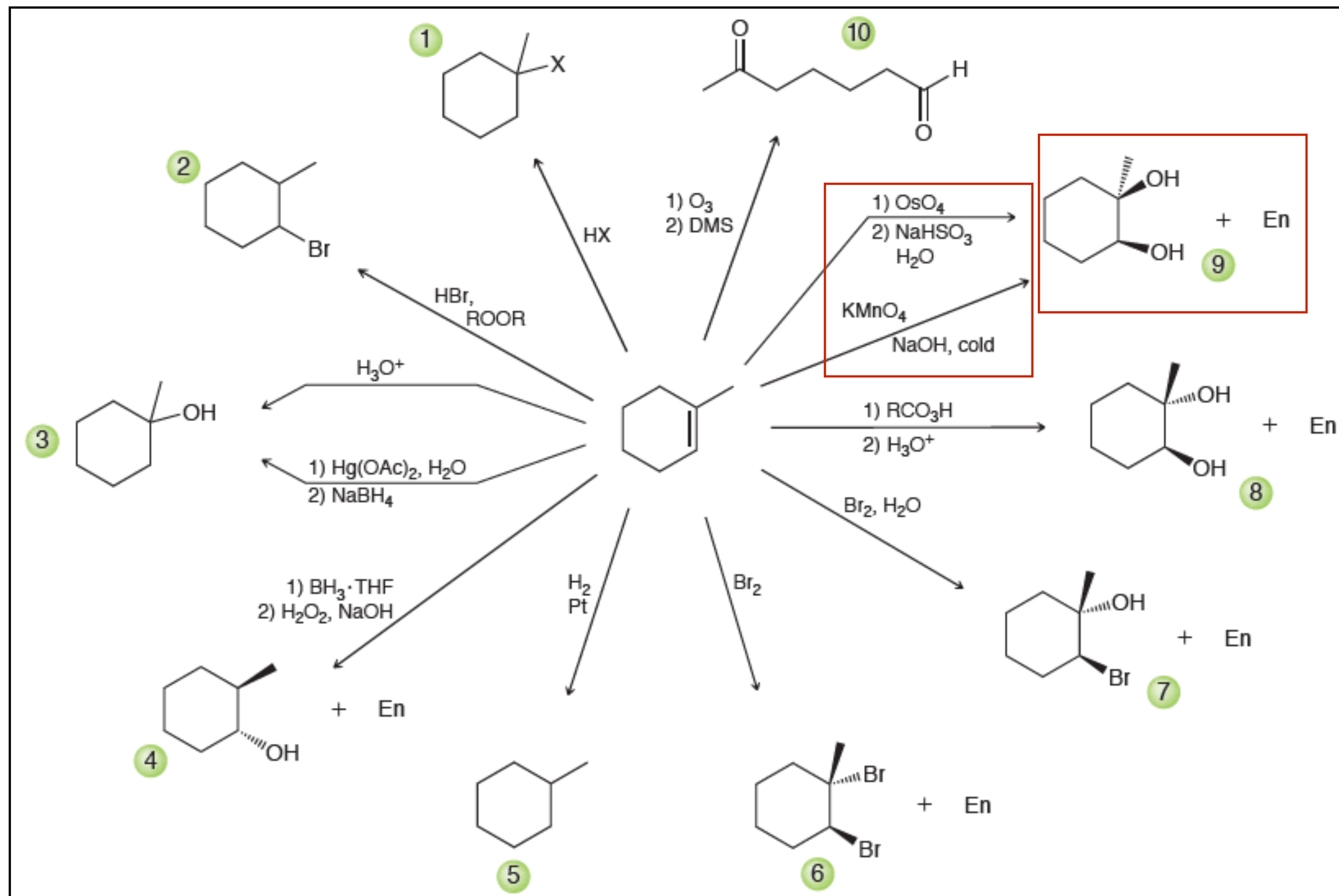


l'addizione di perossiacidi è un'addizione sin



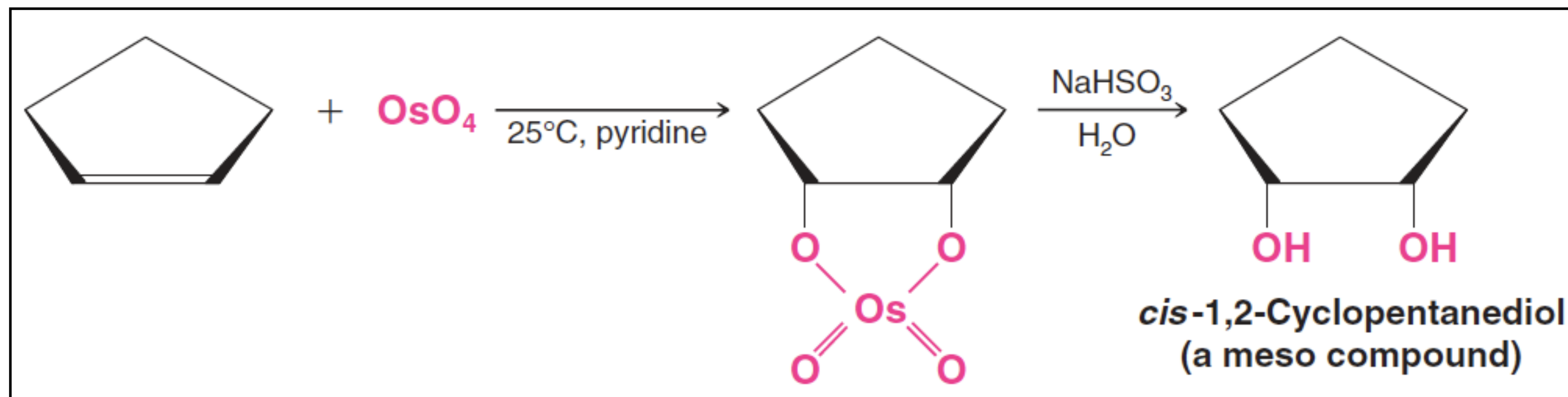
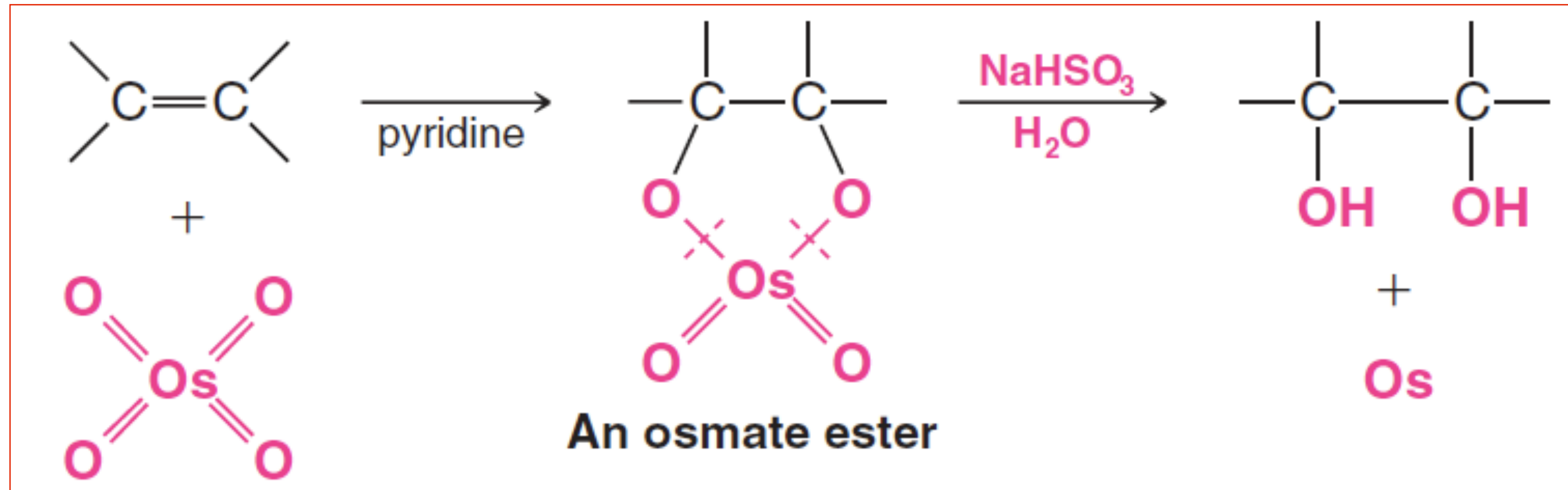
ADDIZIONE nucleofila A UN EPOSSIDO ACIDO CATALIZZATA
(APERTURA DI UN EPOSSIDO IN ACIDO)



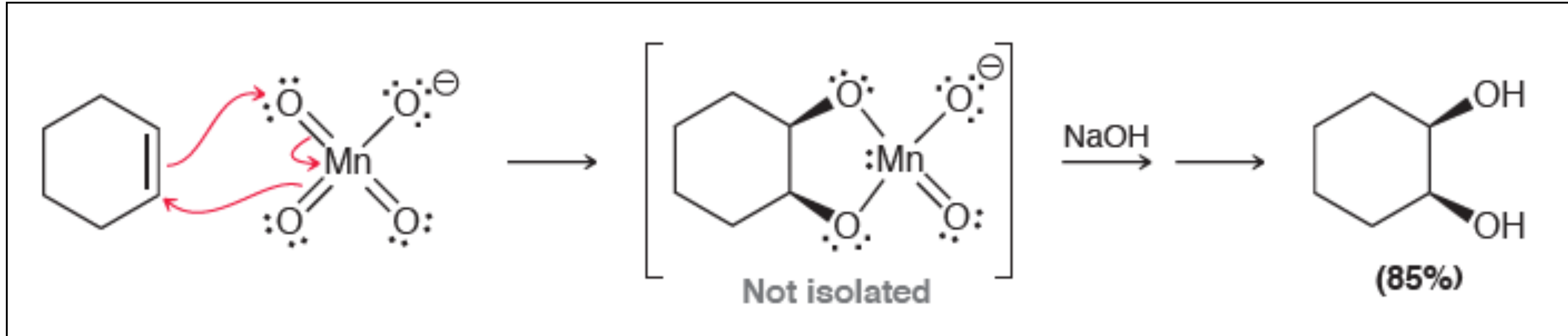
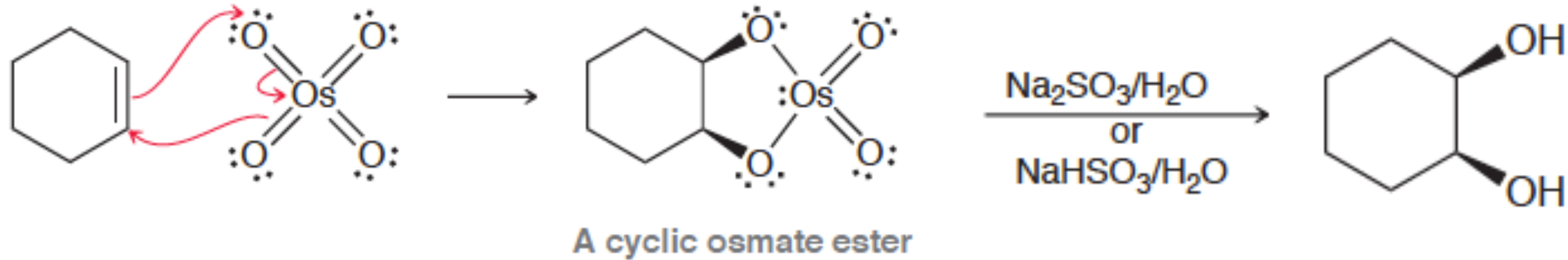


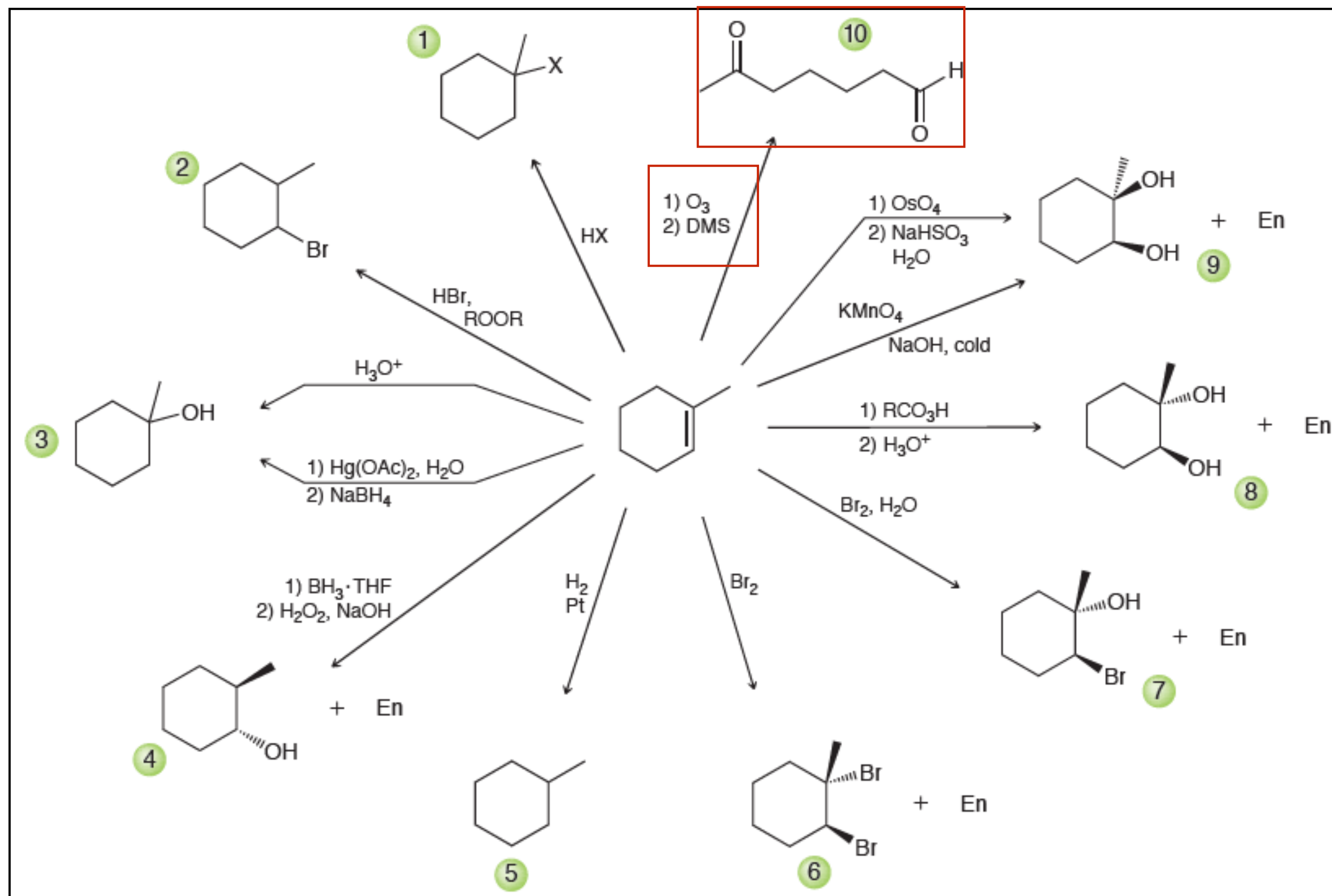
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OSSIDAZIONE DI UN ALCHENE: IDROSSILAZIONE (ADDIZIONE SIN) (FORMAZIONE DI CIS-1,2-DIOLI)



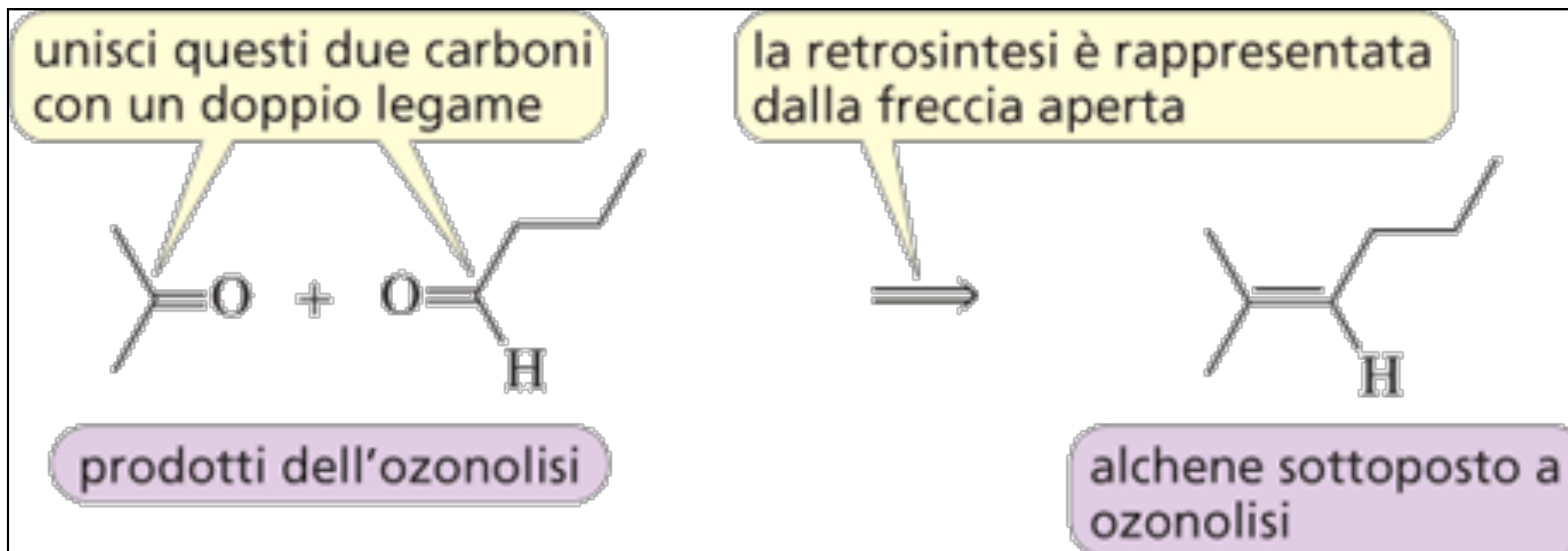
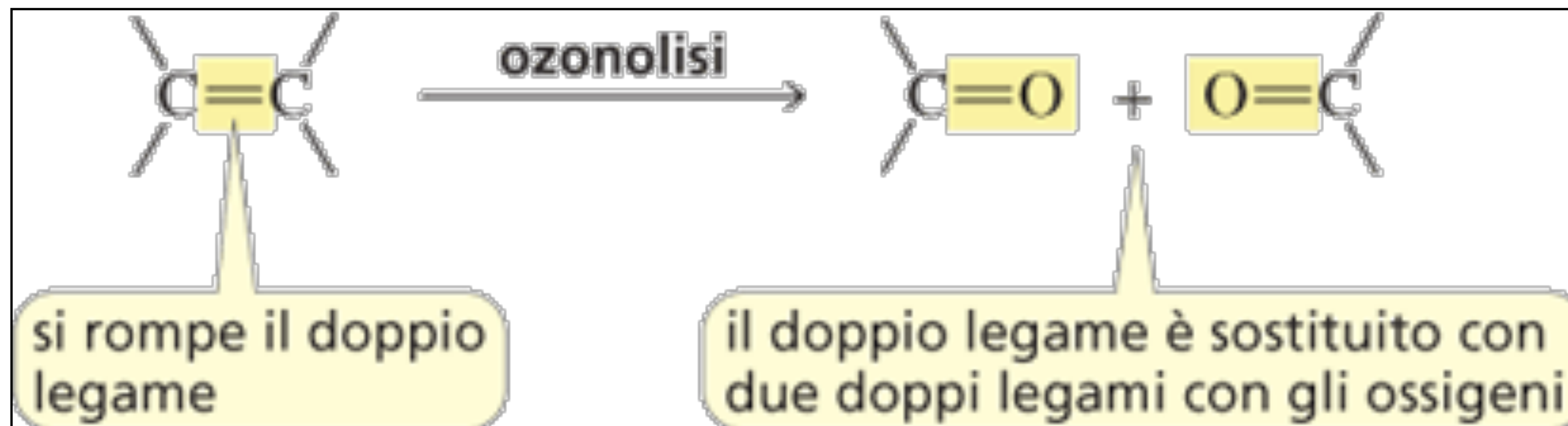
OSSIDAZIONE DI UN ALCHENE: IDROSSILAZIONE (ADDIZIONE SIN) (FORMAZIONE DI CIS-1,2-DIOLI)



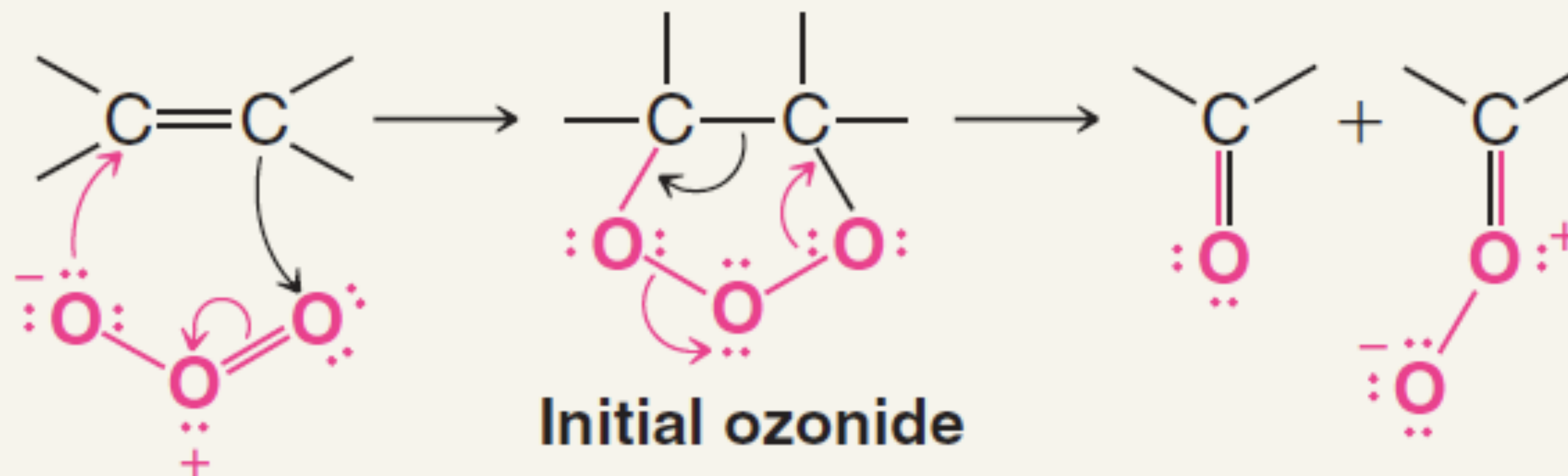


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ADDIZIONE DI OZONO AGLI ALCHENI: L'OZONOLISI

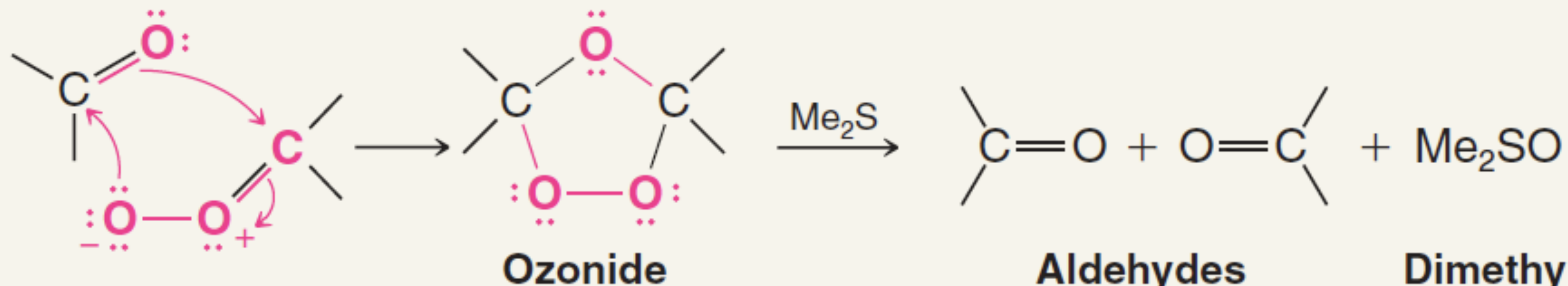


ADDIZIONE DI OZONO AGLI ALCHENI: L'OZONOLISI



Ozone adds to the alkene to form an initial ozonide.

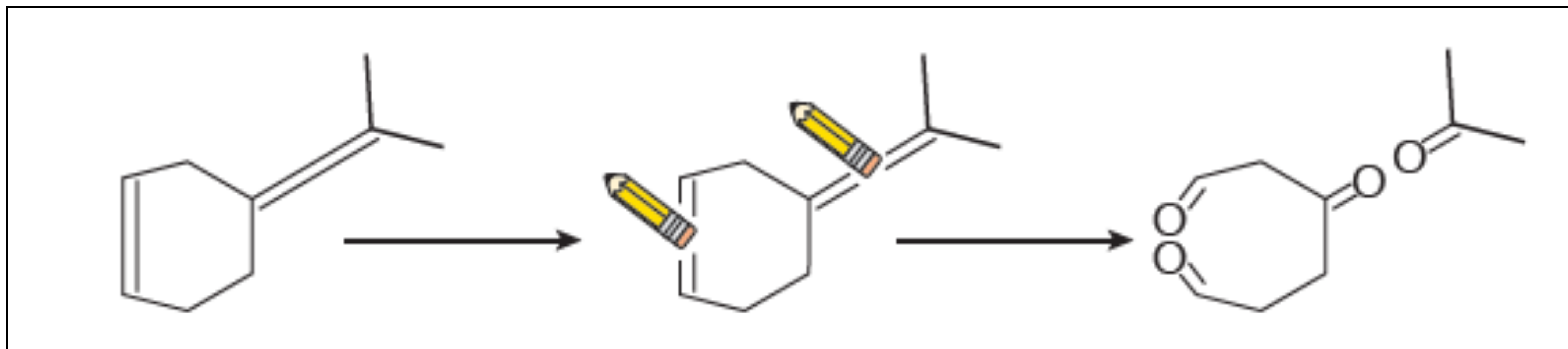
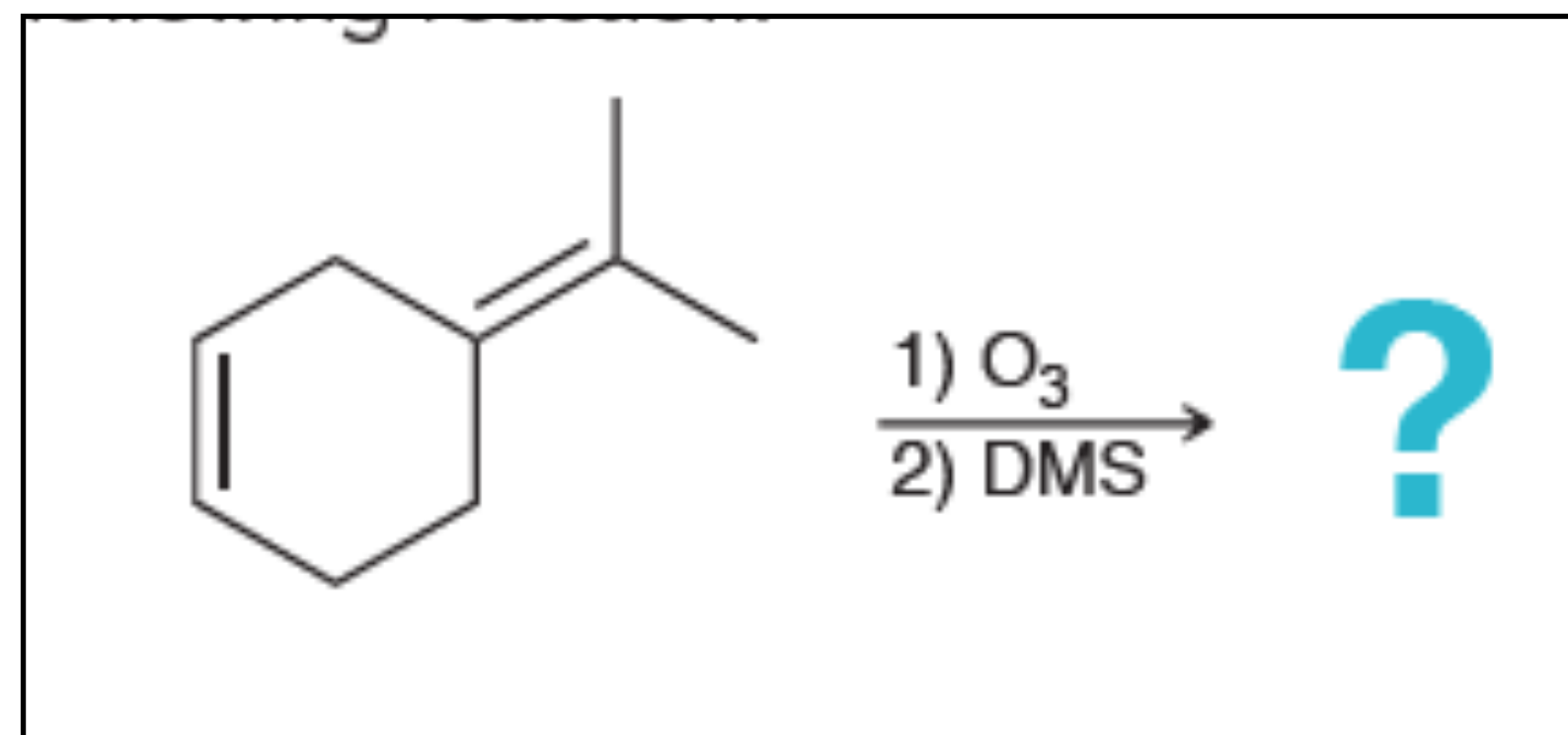
The initial ozonide fragments.



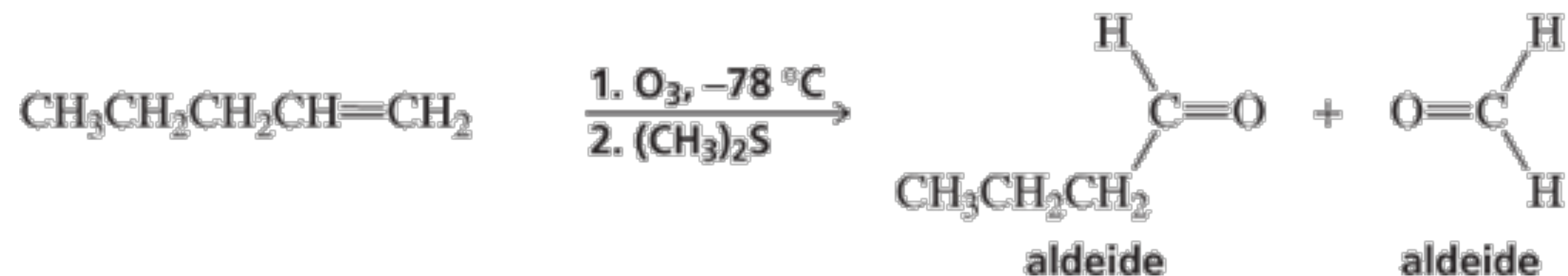
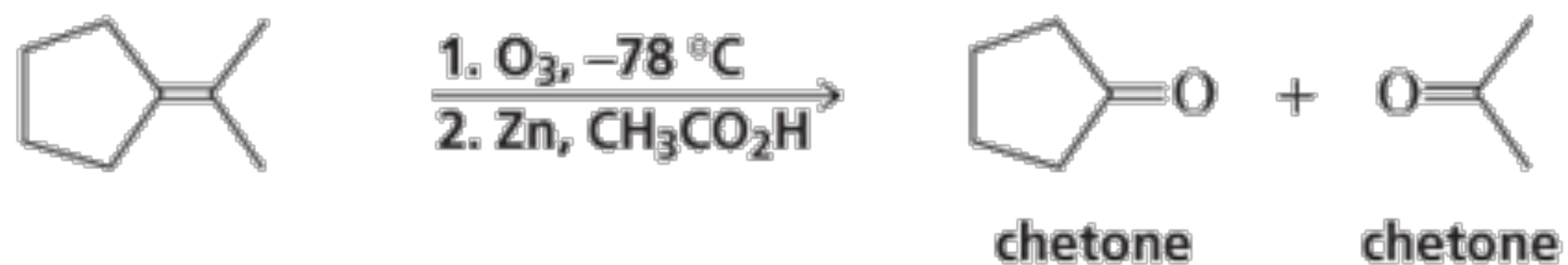
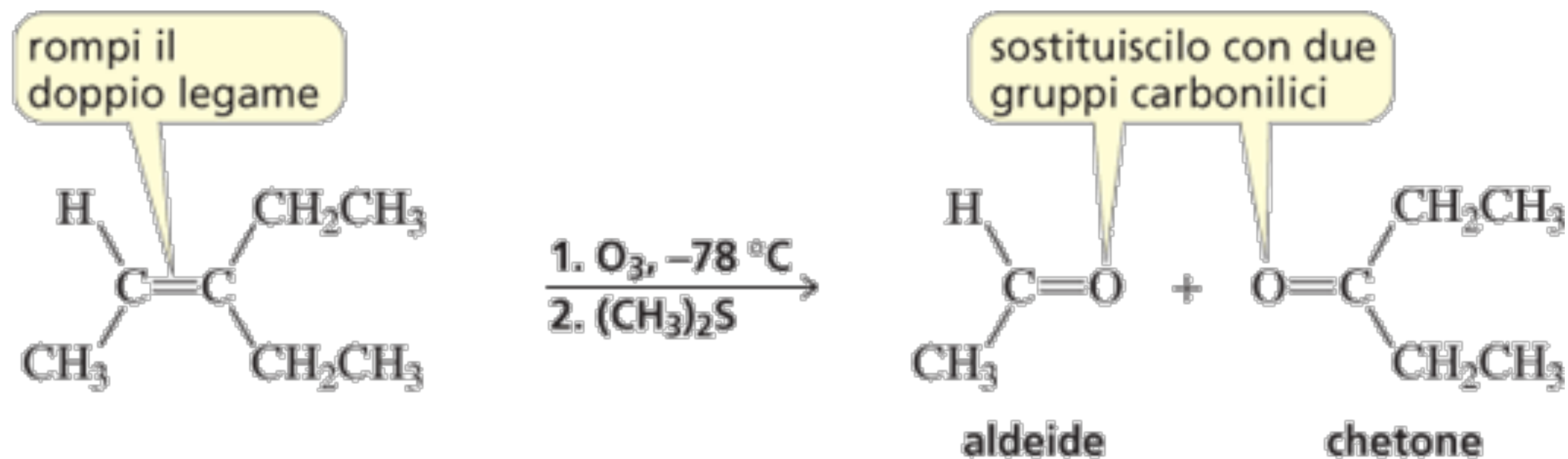
The fragments recombine to form the ozonide.

Aldehydes
and/or ketones

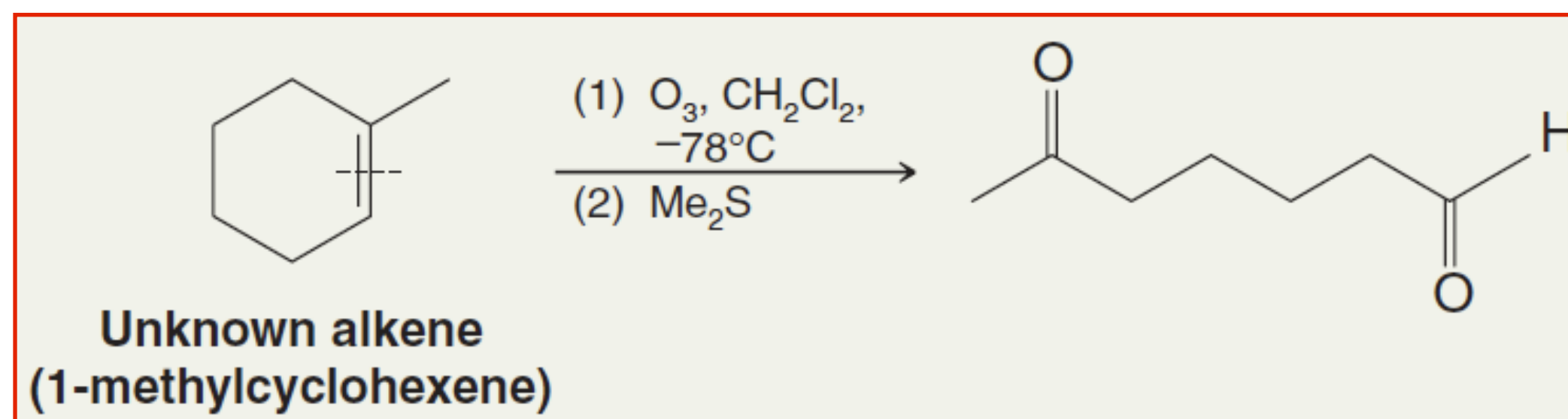
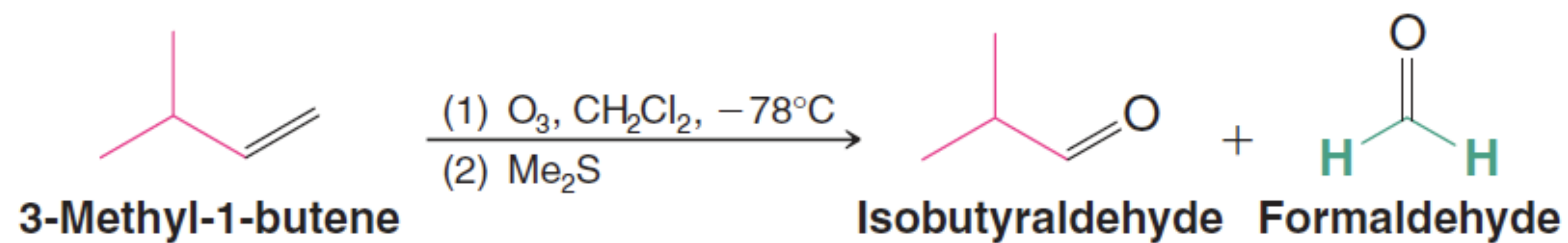
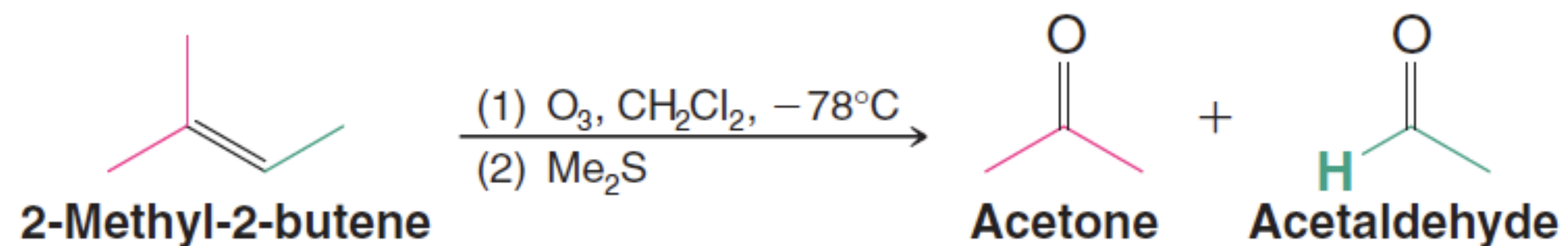
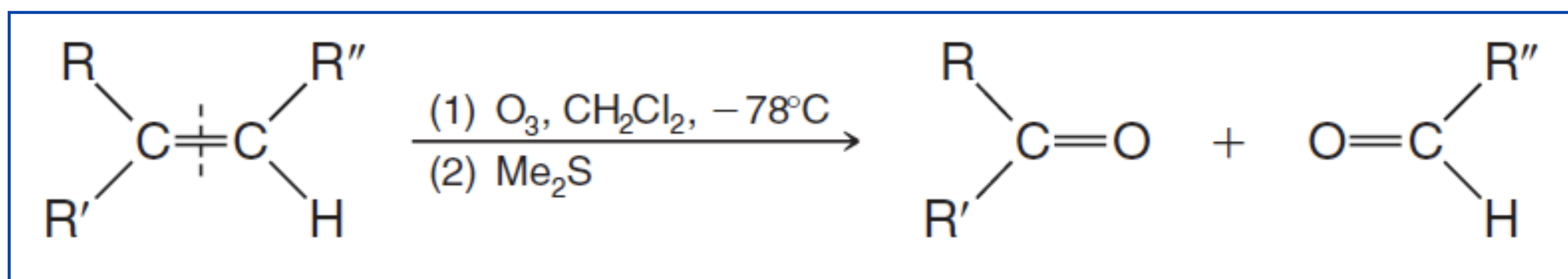
Dimethyl
sulfoxide

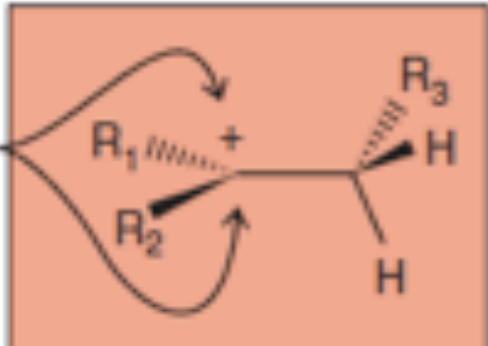
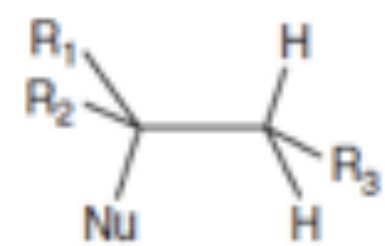
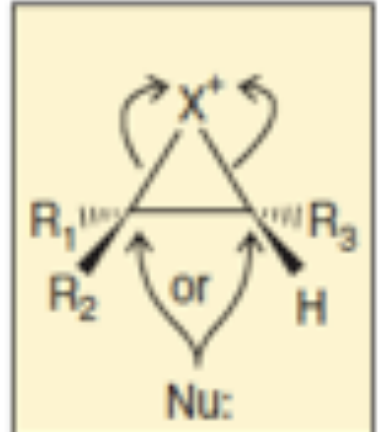
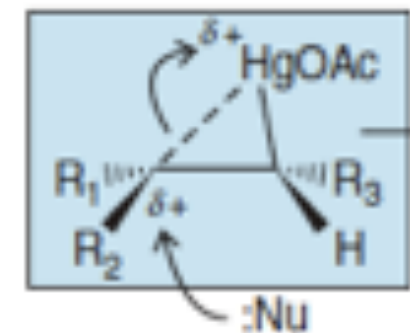
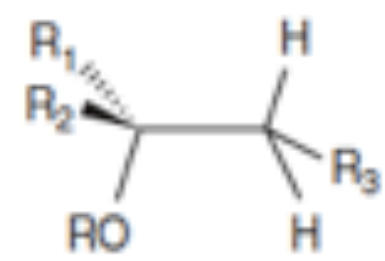
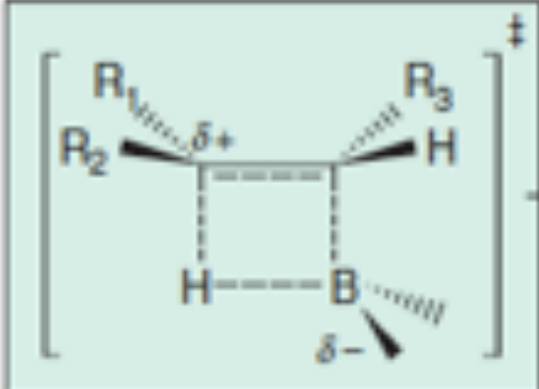
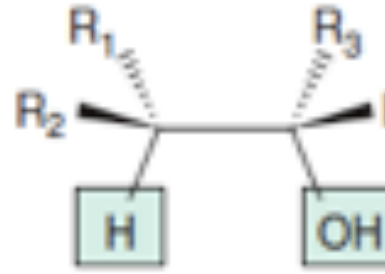
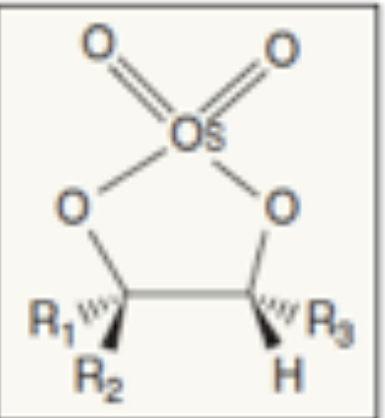
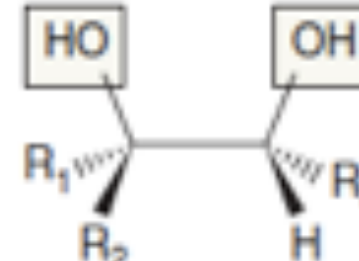


L'ozonolisi ossida gli alcheni ad aldeidi e chetoni.



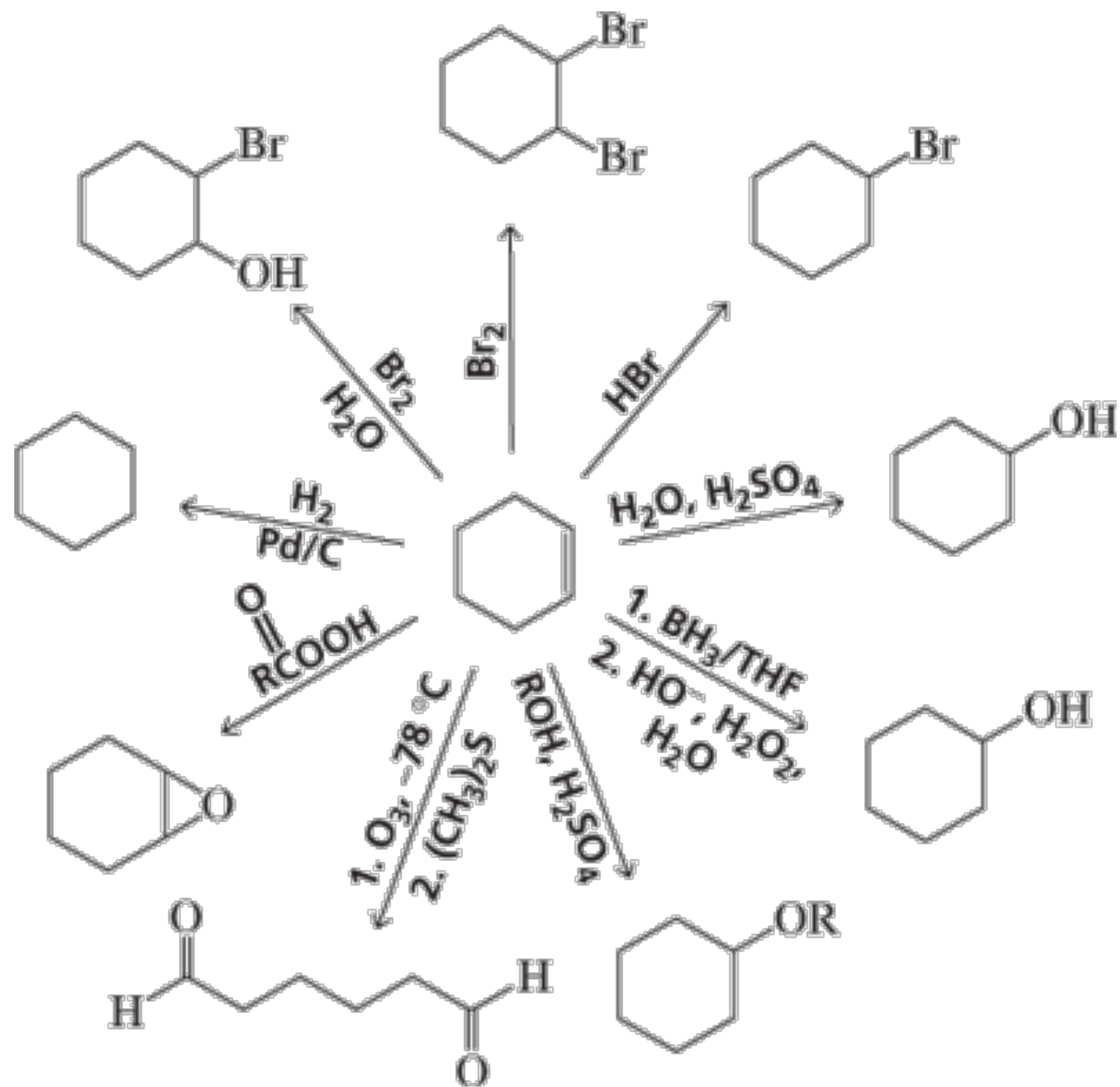
L'ozonolisi ossida gli alcheni ad aldeidi e chetoni.



	$ \begin{array}{c} R_1 \text{ --- } R_3 \\ \diagup \quad \diagdown \\ R_2 \text{ --- } H \end{array} $	$ + \quad E \text{ --- } Nu \quad \longrightarrow $					
	Reaction Conditions	Electrophile	Nucleophile	Key Intermediates or Transition State	Regiochemistry	Stereochemistry of Addition	Product*
Hydrohalogenation	H — X	$\delta^+ H - \delta^- X$	$:X^-$		Markovnikov	Not controlled	
Hydration (acid cat.)	Cat. HA, H ₂ O	$H - \overset{+}{O} - H$	$:O(H)_2$		Markovnikov	Not controlled	 Nu = X or OH
Halogenation	X ₂ (non nucleophilic solvent)	$\delta^+ X - \delta^- X$	$:X^-$		Not applicable	Anti	
Halohydrin Formation	X ₂ , ROH; R = H or C (nucleophilic solvent)	$\delta^+ X - \delta^- X$	$:O(H)R$		Markovnikov	Anti	 Nu = X or OR
Oxymercuration-Demercuration	(1) Hg(OAc) ₂ , HOR; THF (R = H or C) (2) NaBH ₄ , OH ⁻	$HgOAc^+$	$:O(H)R$		Markovnikov	Not controlled	
Hydroboration-Oxidation	(1) BH ₃ :THF (2) H ₂ O ₂ , HO ⁻	$H - B(H)_2$			Net anti-Markovnikov	Syn	
1,2-Dihydroxylation	(1) OsO ₄ (2) aq NaHSO ₃					Syn	

*The generic alkene chosen has a substitution pattern that allows both regiochemistry and stereochemistry of the products to be discerned.

*The products are formed as a mixture of enantiomers in each case.



La stereochimica dei prodotti ottenuti dalle reazioni di addizione elettrofila agli alcheni è riassunta nella Tabella 6.1.

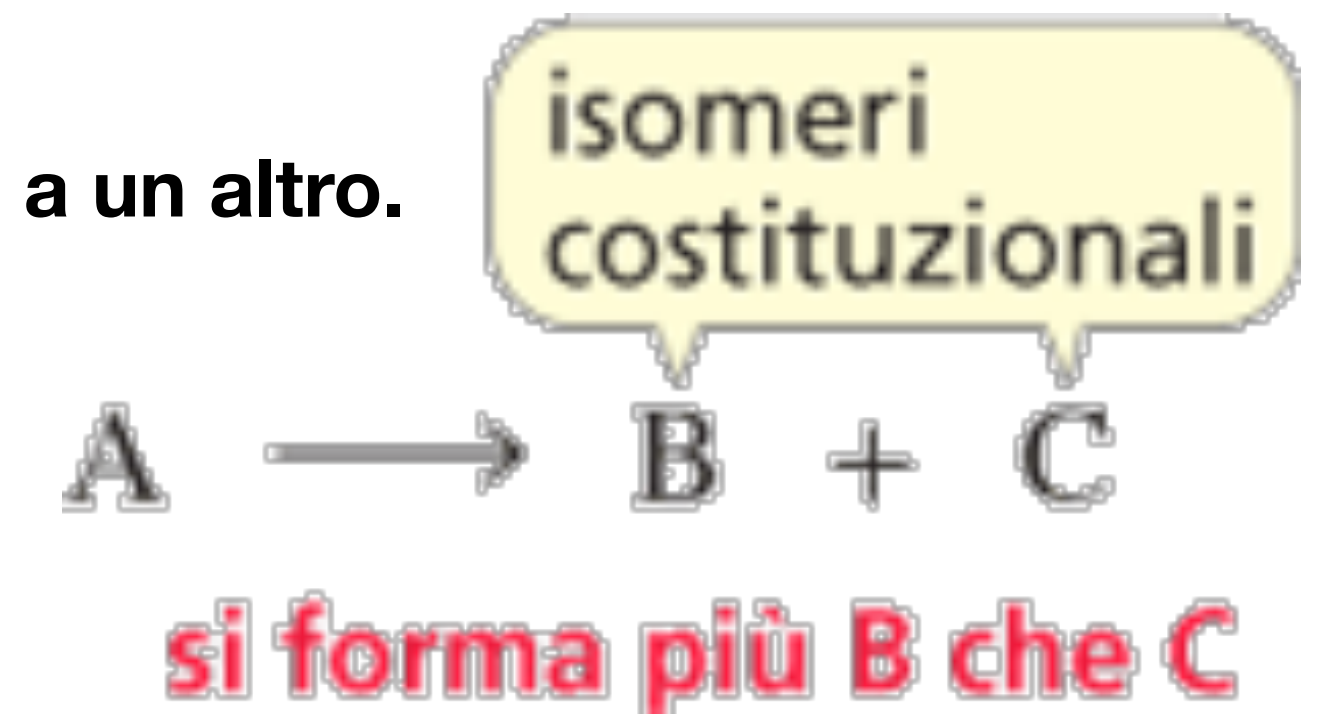
Tabella 6.1 Stereochimica delle reazioni di addizione ad alcheni

Reazione	Tipo di addizione	Stereoisomeri che si formano
Addizioni che formano un centro asimmetrico nel prodotto		Se il reagente non ha centri asimmetrici, si otterrà una miscela racemica.
		Se il reagente ha un centro asimmetrico, si otterranno quantitativi diversi di una coppia di diastereoisomeri.
Addizioni che formano due centri asimmetrici nel prodotto		
Addizioni di reagenti che formano un intermedio carbocationico	sin e anti	Si otterranno quattro stereoisomeri (il cis e il trans formano gli stessi prodotti).
Addizione di H ₂	sin	cis → enantiomeri eritro o cis* trans → enantiomeri treo o trans
Addizione di perossiacidi	sin	
Addizione di BH ₃ o BHR ₂	sin	
Addizione di Br ₂ , Br ₂ + H ₂ O, Br ₂ + ROH (ogni reazione che forma uno ione bromonio ciclico come intermedio)	anti	cis → enantiomeri treo o trans trans → enantiomeri eritro o cis*

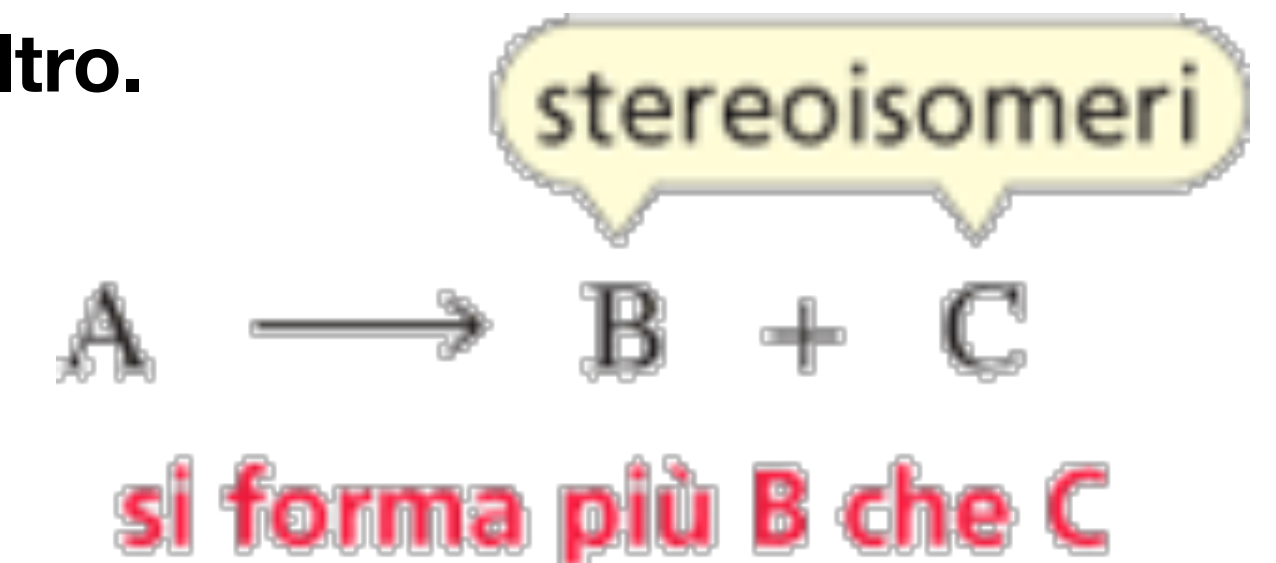
*Un composto aciclico forma gli enantiomeri eritro; un composto ciclico forma gli enantiomeri cis. Se i due centri asimmetrici hanno gli stessi sostituenti, si otterrà un composto meso invece che una coppia di enantiomeri eritro o cis.

REAZIONI REGIOSELETTIVE, STEREOSELETTIVE E STEREOSPECIFICHE

Una **reazione regioselettiva** forma un isomero costituzionale in quantità maggiore rispetto a un altro.



Una **reazione stereoselettiva** forma uno stereoisomero in quantità maggiore rispetto a un altro.



Una **reazione è stereospecifica** se il reagente può esistere sotto forma di diversi stereoisomeri e ciascuno stereoisomero del reagente produce un diverso stereoisomero del prodotto o una diversa serie di stereoisomeri.



6B. Le reazioni degli alcheni

- (1) Addizione di acqua e acidi alogenidrici agli alcheni. Stabilità dei carbocationi.
- (2) Trasposizione dei carbocationi.
- (3) Regioselettività delle reazioni di addizione elettrofila (Regola di Markovnikov).
- (4) Addizione radicalica (anti-Markovnikov).
- (5) Idroborazione-ossidazione degli alcheni.
- (6) Addizione di alogeni agli alcheni.
- (7) Addizione di un perossiacido agli alcheni (epossidazione).
- (8) Addizione di ozono agli alcheni (ozonolisi).
- (9) Stereochimica delle reazioni di addizione agli alcheni: reazione regioselettiva, stereoselettiva o stereospecifica.