

4. Előadás

Szénhidrogének:
alkánok, alkének, alkinek, arének.
Terpének, karotinoidok.

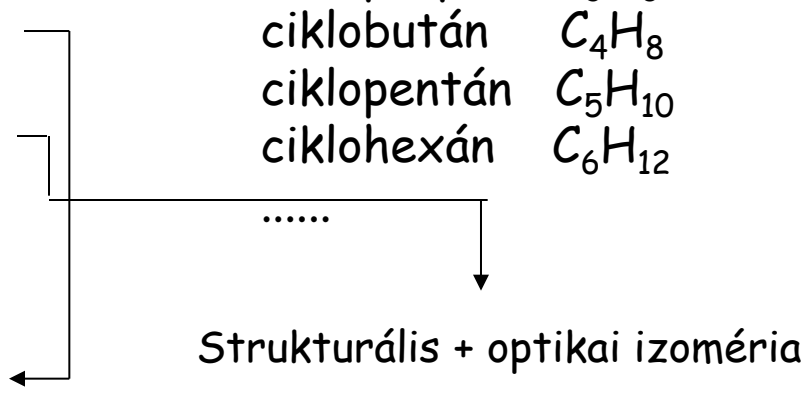
19. Szénhidrogének

19.1. Alkánok (paraffinok), cikloalkánok

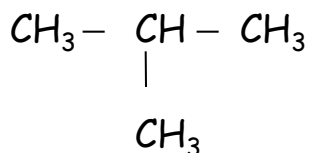
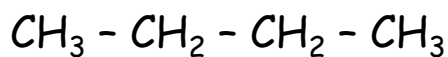
Homológ sor: eltérés egyetlen metilén (CH₂) csoportban

metán	CH ₄	1
etán	C ₂ H ₆	1
propán	C ₃ H ₈	1
bután	C ₄ H ₁₀	2
pentán	C ₅ H ₁₂	
heptán	C ₇ H ₁₆	9
...		
dekán	C ₁₀ H ₂₂	75
....		

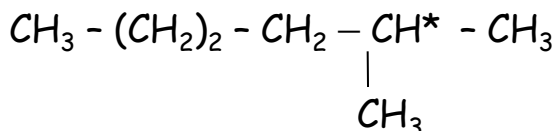
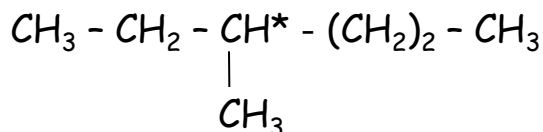
ciklopropán	C ₃ H ₆
ciklobután	C ₄ H ₈
ciklopentán	C ₅ H ₁₀
ciklohexán	C ₆ H ₁₂
.....	



Strukturális izoméria



Strukturális + optikai izoméria

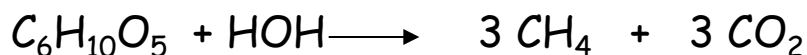


Előfordulás : metán,

Jupiter, Saturnusz, Uranusz, Neptun (redukáló atmoszféra)

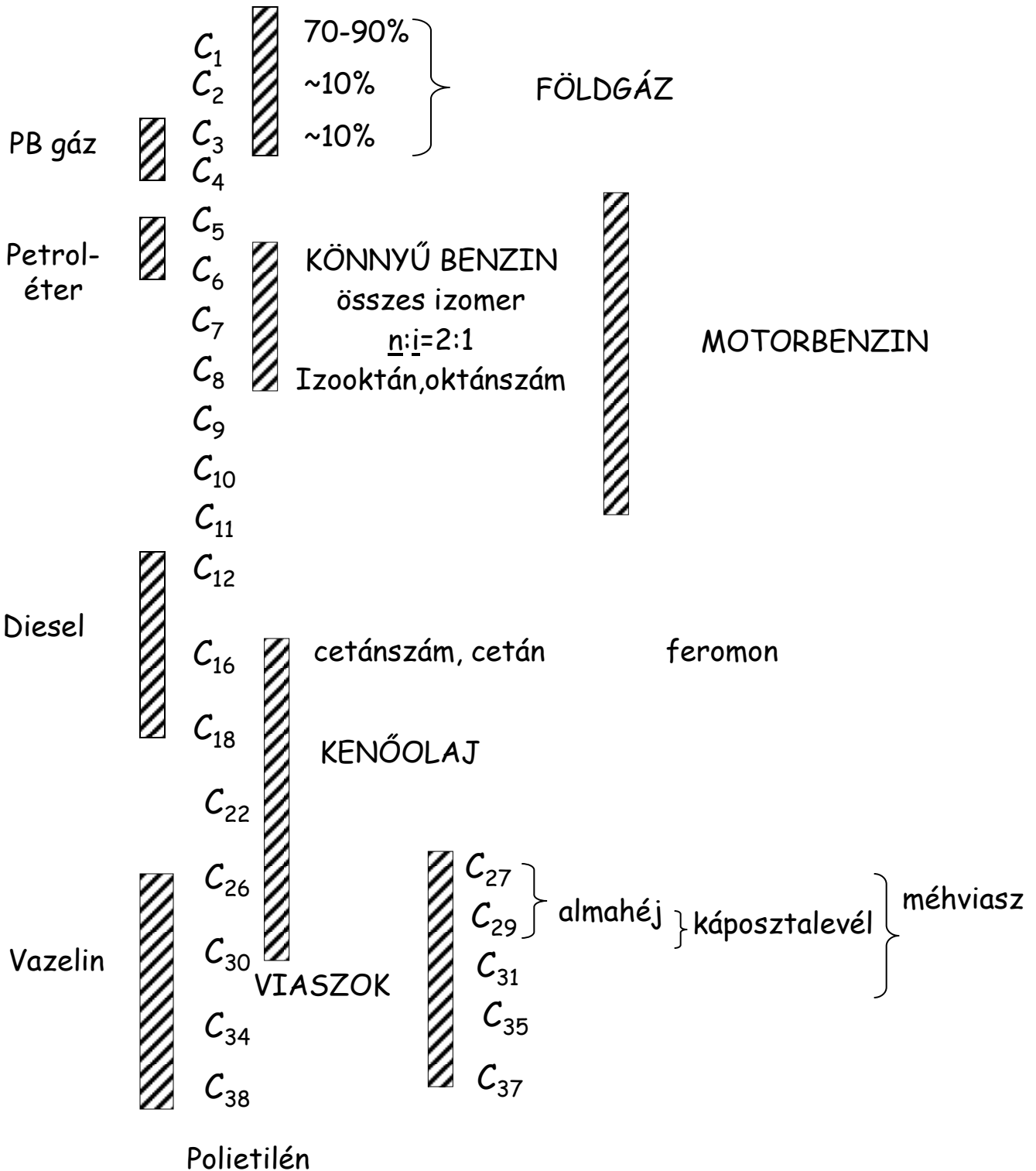
Föld (oxidáló atmoszféra)

- Anaerob baktériumok (Archeobacterium, metanogén)



- Tehén 20 liter/nap

Előfordulás



Az alkánok szerkezete

KÖTÉS MÓD

$C(sp^3) - C(sp^3)$

$C(sp^3) - H(s)$

KÖTÉSHOSSZ

$r(C - C) = 1.54 \text{ \AA}$

$r(C - H) = 1.09 \text{ \AA}$

KÖTÉSSZÖG

HCH $\neq 109^\circ$

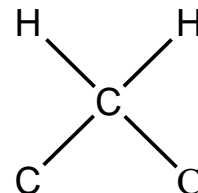
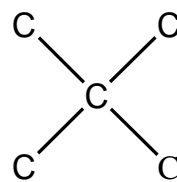
$109^\circ (CH_4)$

CCC $\neq 109^\circ$

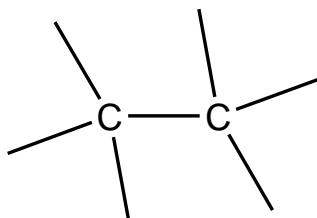
112°

SZÖGFESZÜLTÉSÉG:

10° TORZULÁS $\sim 7.1 \text{ kJ/mol}$



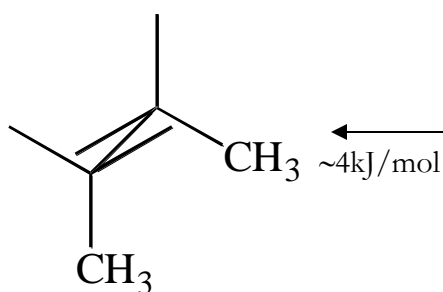
KÖTÉSI
ENERGIA



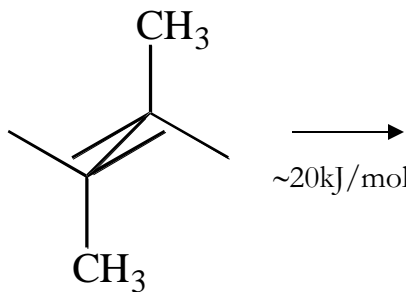
360 kJ/mol

KONFIGURÁCIÓ
KONFORMÁCIÓ

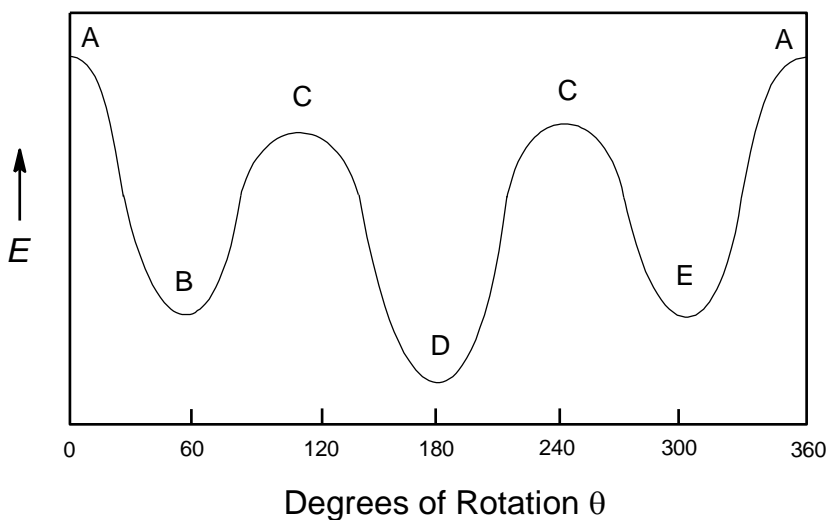
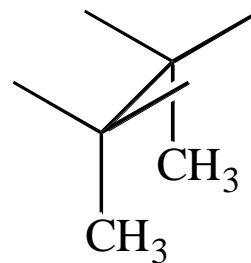
TETRAÉDERES
ZEG-ZUGOS



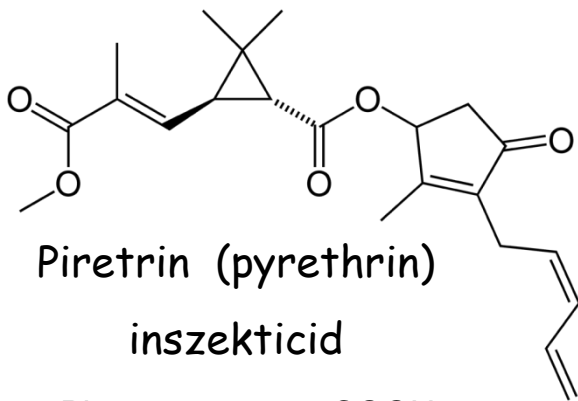
$\sim 4 \text{ kJ/mol}$



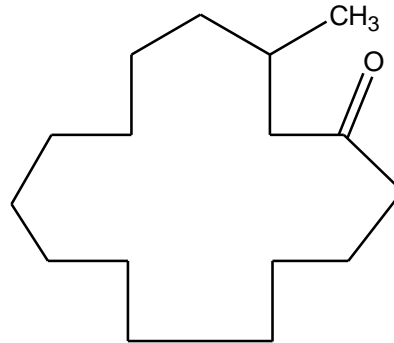
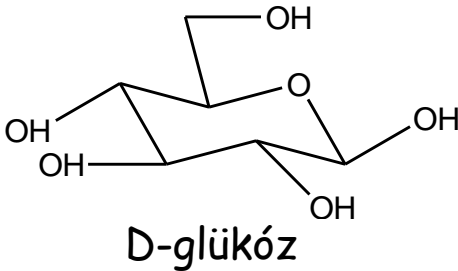
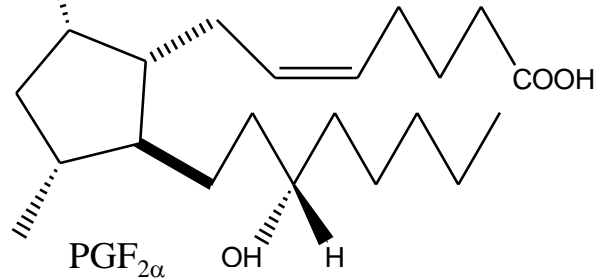
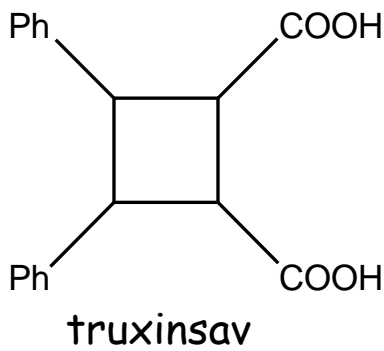
$\sim 20 \text{ kJ/mol}$



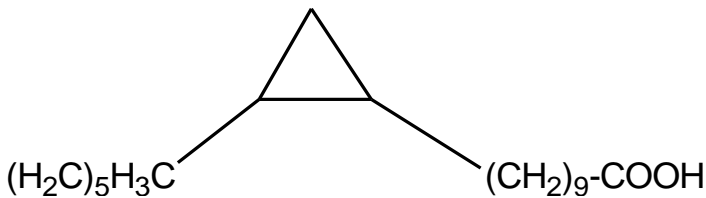
Cikloparaffinok előfordulása



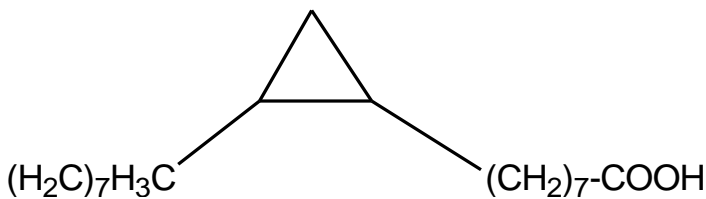
Chrysanthemum / Tanacetum



pézsmapatkány



laktobacillinsav



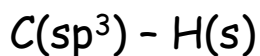
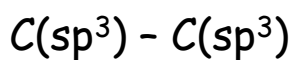
SZTEROIDOK

szterkullinsav

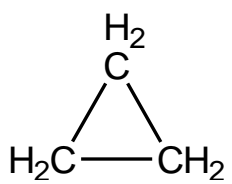
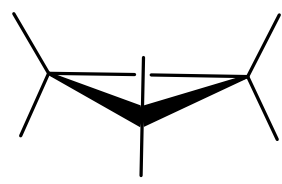
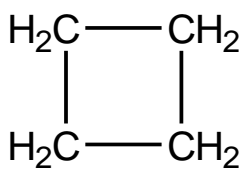
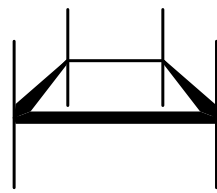
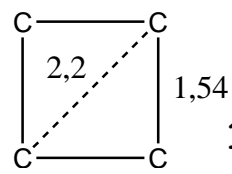
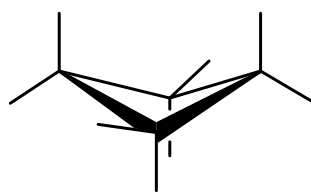
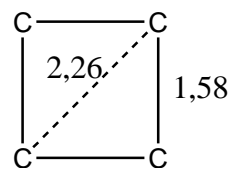
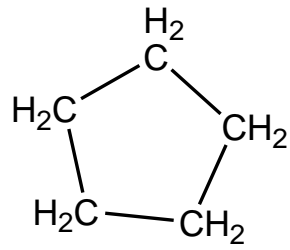
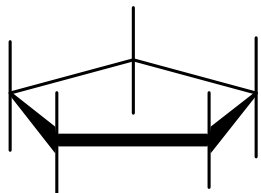
Sterculia foelida - fa magvában

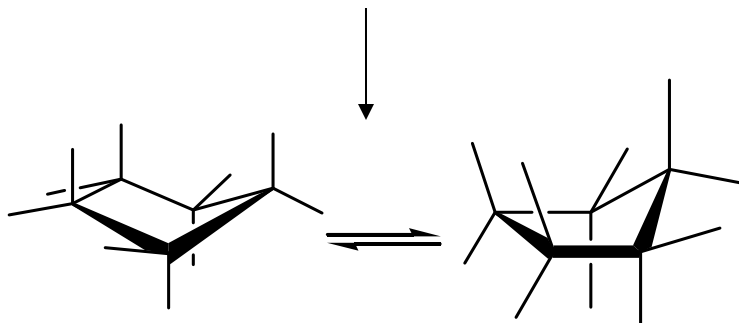
A cikloalkánok szerkezete

KÖTÉSMÓD:



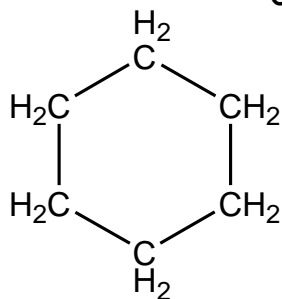
KÖTÉSRENDSZER:

	SZÖGFESZÜLTSÉG	TORZIÓS	KÖTÉSI	Σ [kJ/mol]
	$109,5^\circ - 60^\circ = 49,5^\circ$		nincs	115,1
	$109,5^\circ - 90^\circ = 19,5^\circ$			109,1
		↓		
				
		↓		
	$109,5^\circ - 108^\circ = 1,5^\circ$			25,8
		↓		

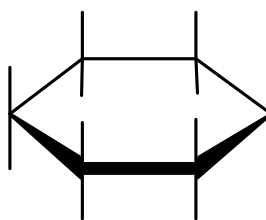


Csavart kád

Boríték



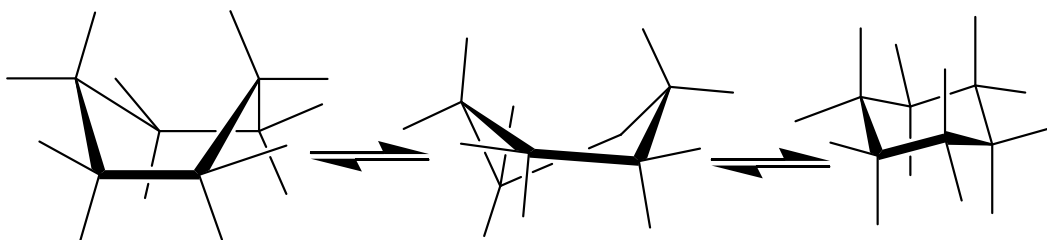
$109,5^\circ - 120^\circ = -10,5^\circ$



0,5

Baeyer-modell

SACHE - MOHR - MODELL



0

KÁD

CSAVART KÁD

SZÉK

Szögfeszültség

nincs

nincs

nincs

Torziós feszültség

van

nincs

nincs

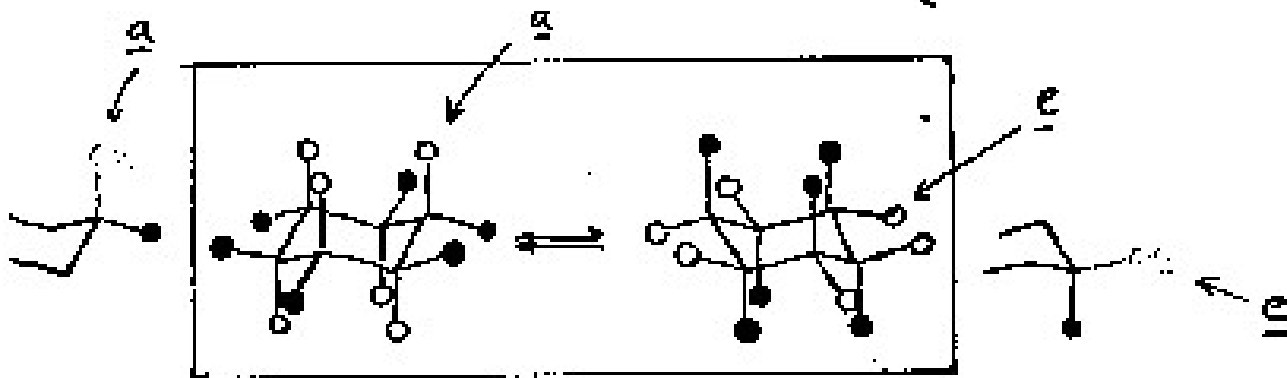
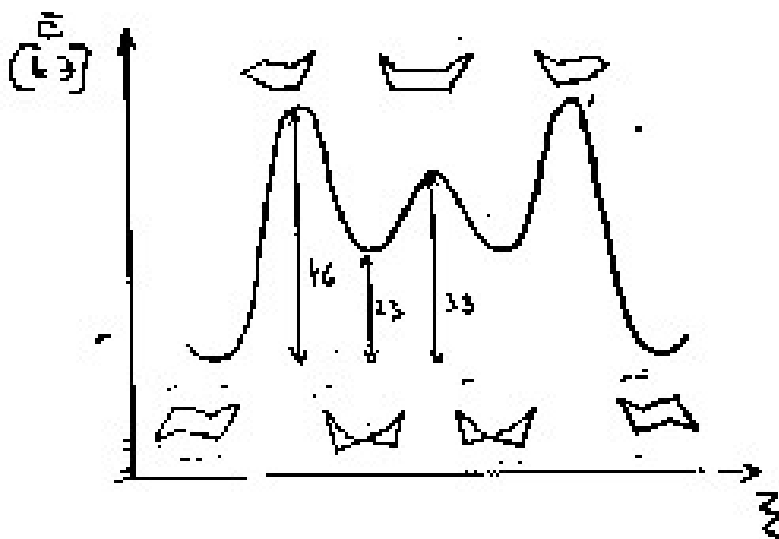
Non-bonded feszültség

van

nincs

nincs

Szobahőmérsékleten dinamikus egyensúly



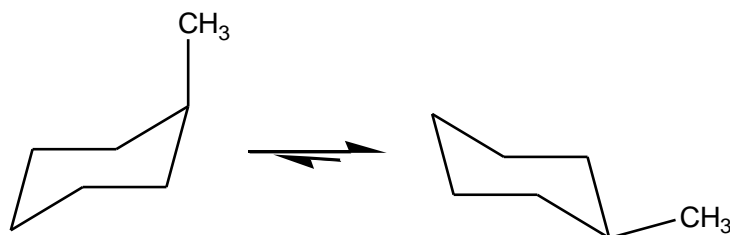
Ekvatoriális (egyenlítői) helyzet: Jele: e

a gyűrű síkjában

Axiális helyzet: Jele: a

a gyűrű síkjára merőleges

Példa:

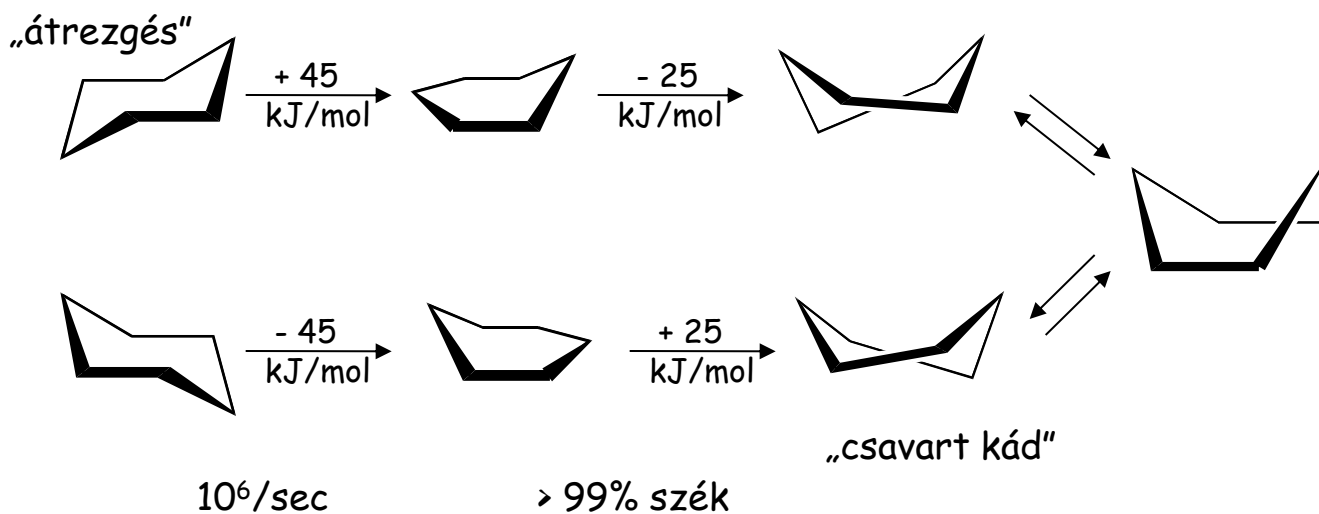
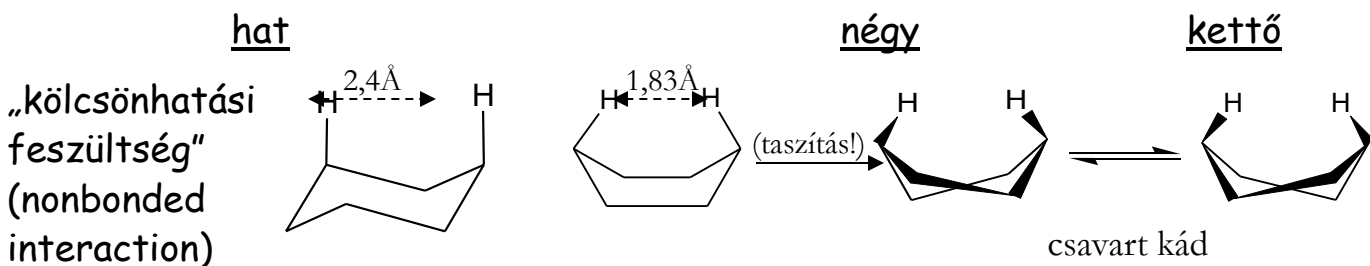
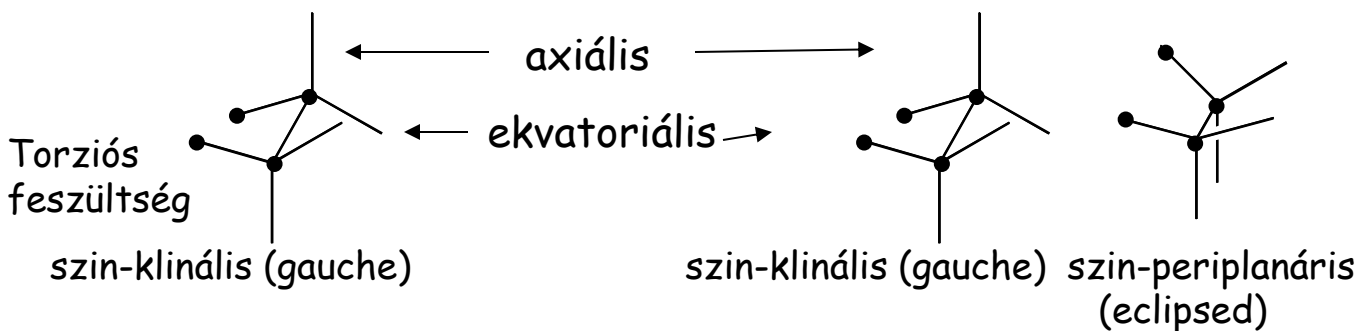
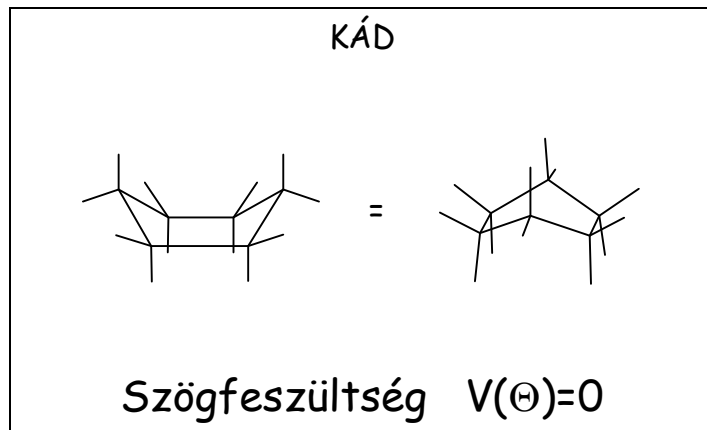
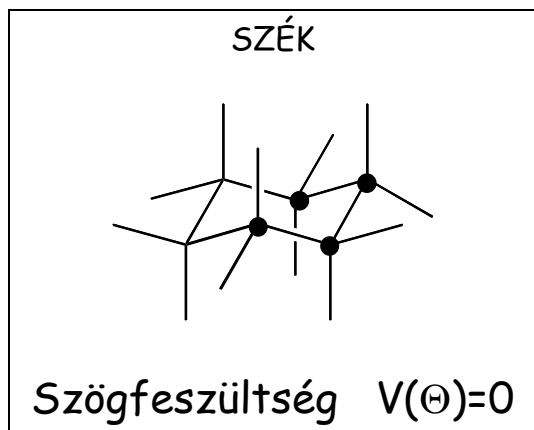


a-metil ciklohexán

Arány 6: 94

ΔE : 7 kJ/mol

Ciklohexán



Fizikai tulajdonságok

1. Halmazállapot [jellemzői: olvadáspont, forráspont]
2. Kölcsönhatás fényel (de: nem kötésfelbontás)
 - szín
 - forgatás $[\alpha]$
 - törésmutató n
3. Szag
4. Oldékonyság [oldószer, hőmérséklet, nyomás]
5. Sűrűség [hőmérséklet]

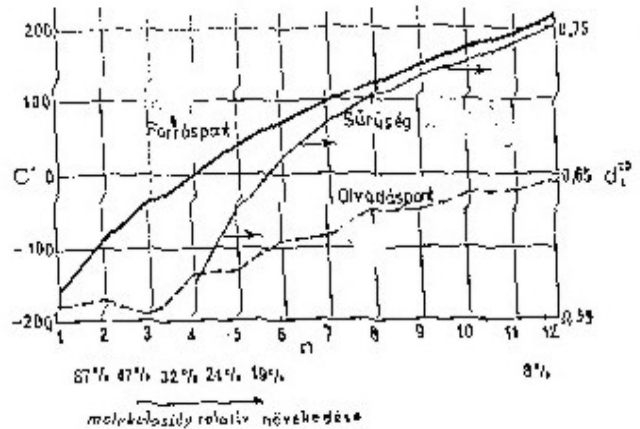
HALMAZÁLLAPOT

Kohéziós erők

C_{1-4} gáz

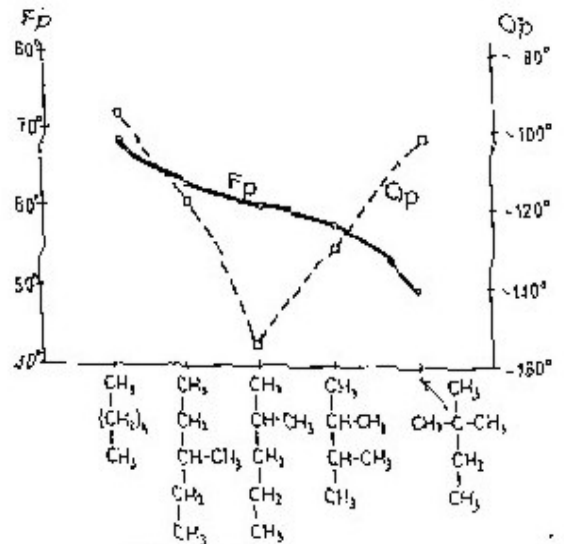
C_{5-16} folyadék,
van der Waals erők

C_{17} szilárd kristályrács:
semleges molekulák



OLDÉKONYSÁG

Hasonló hasonlót old
Pl: Apoláros (pl. benzol)
v. kevésbé poláros oldószerben



Alkánok és cikloalkánok reakciói

1. Oxidáció - redukció
 2. Halogénezés
 3. Nitrálás
- } Szobahőmérsékleten nincs kötésehasadás

A kémiai reakció körülményei:

Hőmérséklet (Δ)

Nyomás

Reakcióidő (t)

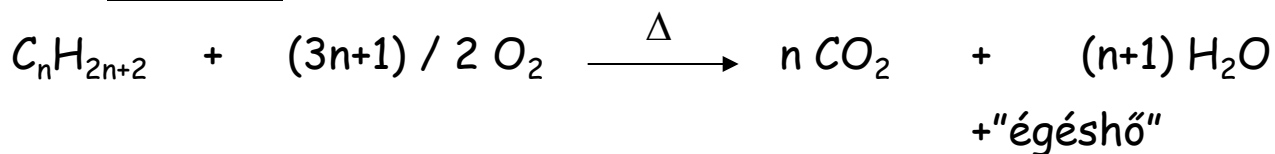
Katalizátor (kat)

Koncentráció - abszolút

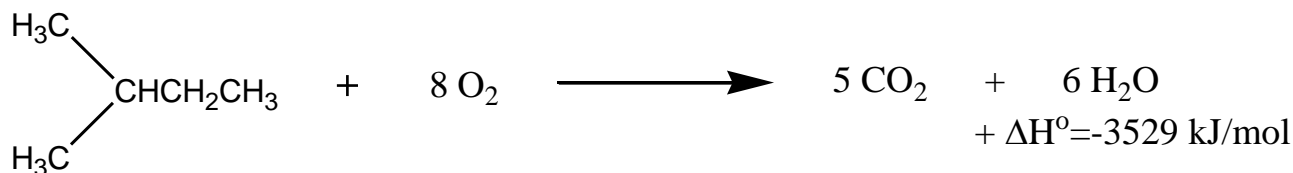
- relativ (mol arány)

Fény ($h\nu$)

1. Oxidáció



Példa



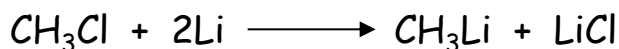
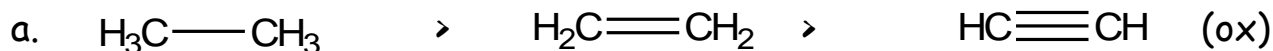
Oxidáció szám

Tegyük fel, hogy az O oxidációs száma -2 és a H oxidációs száma +1

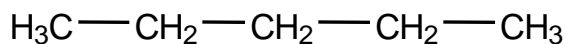
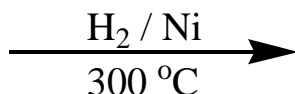
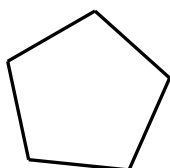
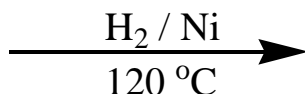
a C oxidációs száma:

Metán	CH_4	-4	$\text{C}-\text{H}$
Metanol	CH_3OH	-2	$\text{C}-\text{O}$
Formaldehid	CH_2O	0	$\text{C}=\text{O}$
Hangyasav	HCOOH	+2	$\begin{array}{l} \text{O} \\ // \\ \text{C} \\ \backslash \\ \text{O}-\text{H} \end{array}$
Széndioxid	CO_2	+4	$\begin{array}{l} \text{O} \\ // \\ \text{C} \\ // \\ \text{O} \end{array}$
Redukált forma:	CH_4		
Oxidált forma:	CO_2		

Alkalmazás:

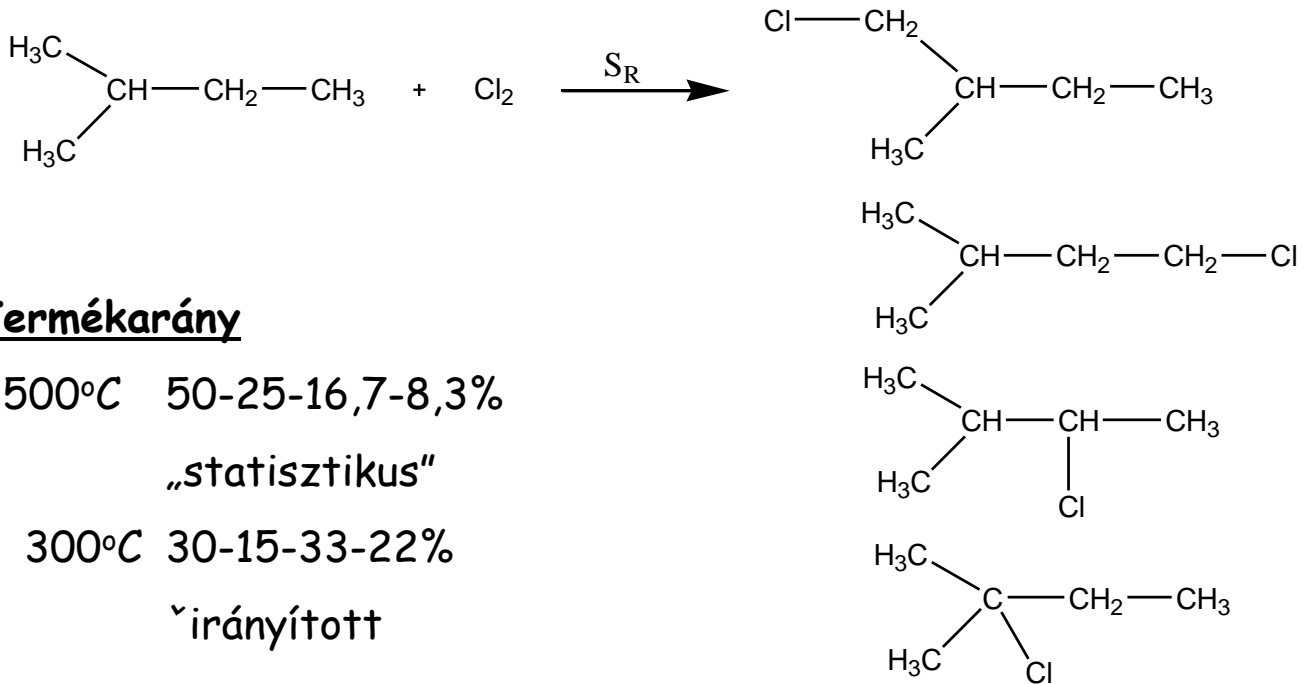


2. Redukció - hidrogénezés



3. Halogénezés

a



Termékarány

> 500°C 50-25-16,7-8,3%

„statisztikus”

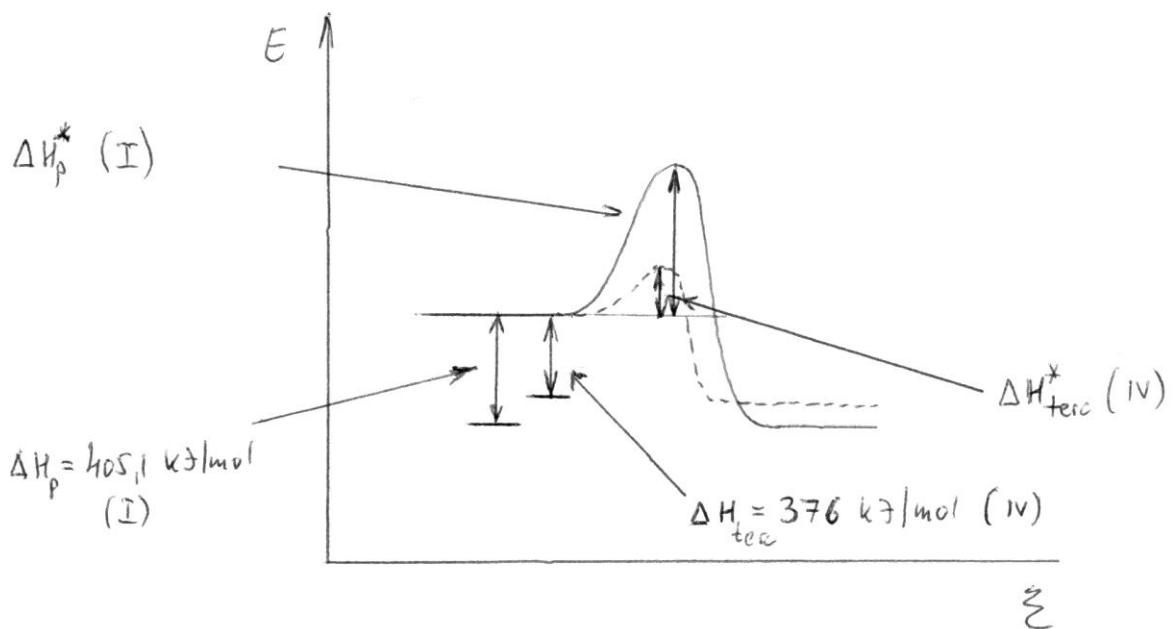
300°C 30-15-33-22%

irányított

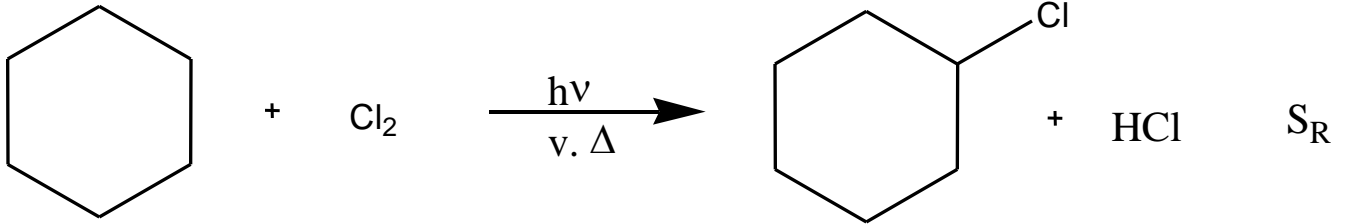
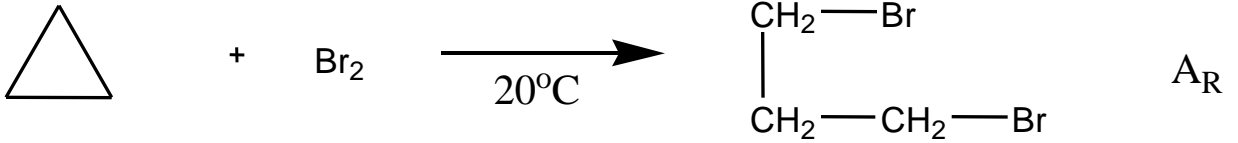
Disszociációs energia:

$\Delta H > \Delta H > \Delta H > \Delta H$, és $\Delta H^* > \Delta H^* > \Delta H^* > \Delta H^*$

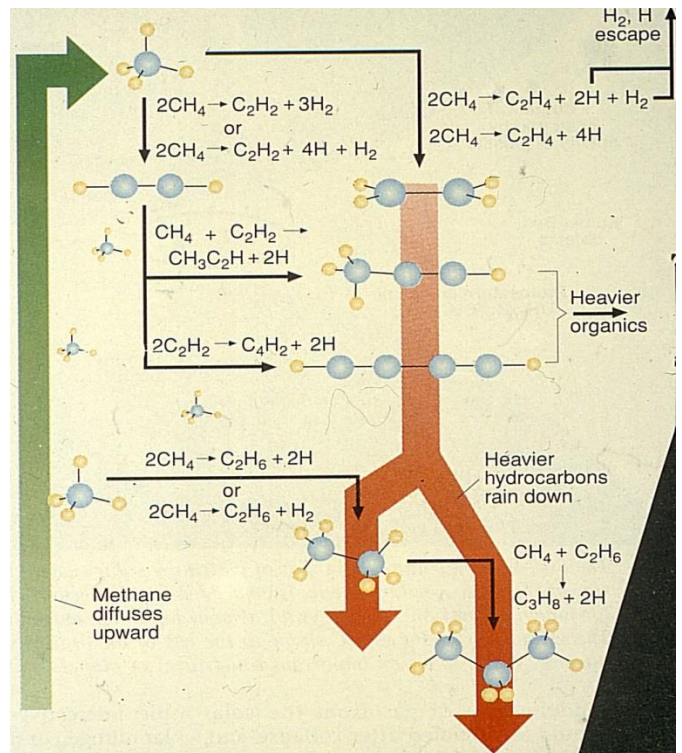
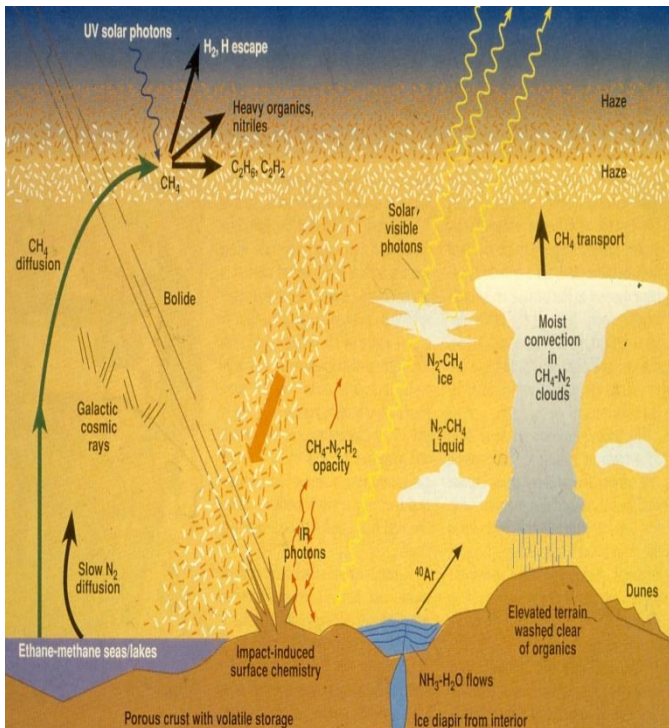
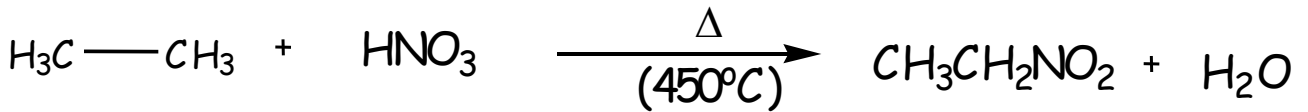
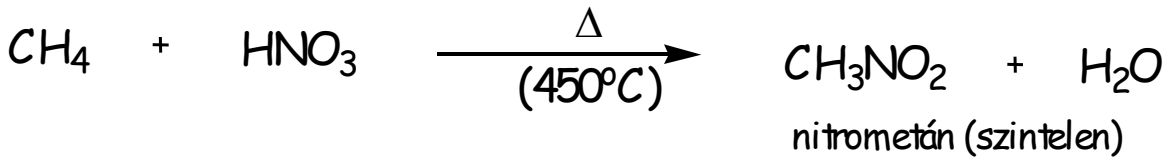
(metil) (primer) (szek) (terc)



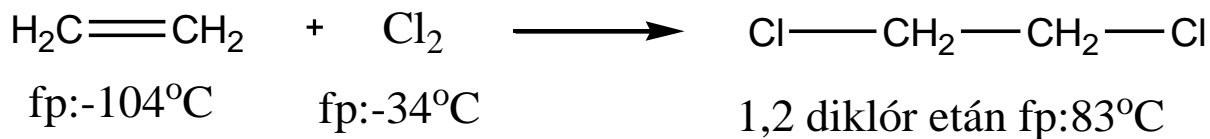
b.



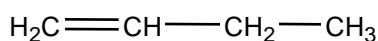
3. Nitrálás



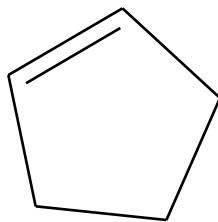
19.2. ALKÉNEK, CIKLOALKÉNEK (gaz oléfiánt, olefin, olajképző gáz 1795)



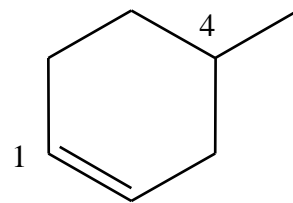
PÉLDÁK:



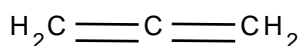
1-butén



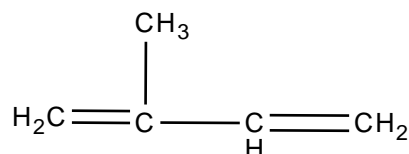
ciklopentén



4-metil - 1 -ciklohexén

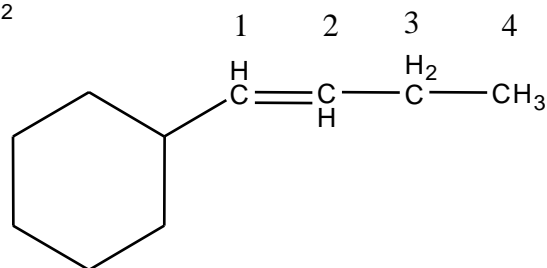


1,2-propadién (allén)

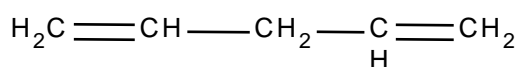


2-metil-1,3-butadién

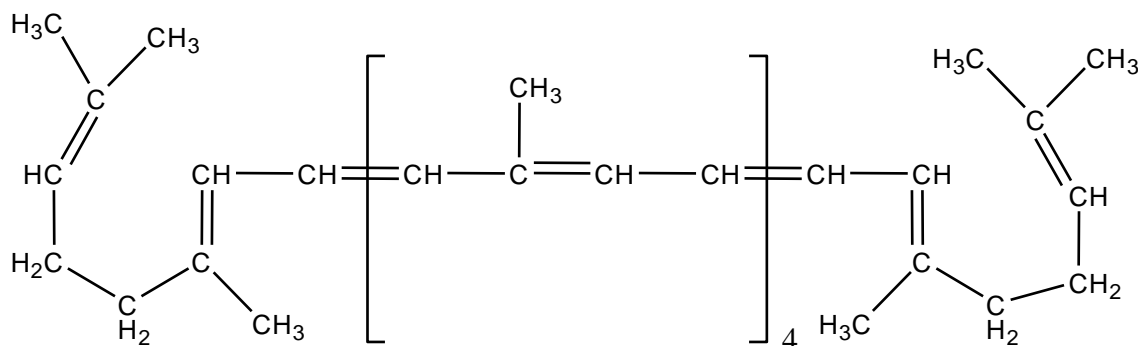
(izoprén*)



1-ciklohexil-1-butén



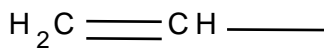
1,4-pentadién



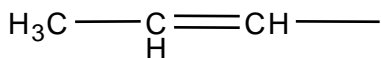
Likopin* (paradicsom pigment)

CSOPORTNEVEK

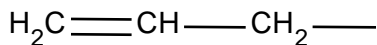
alkenil (cikloalkenil)



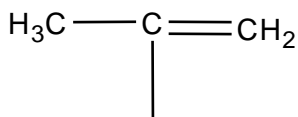
„etenil” vinil*



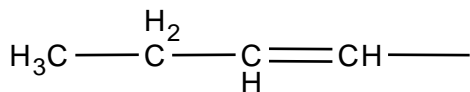
allil*



propenil*



izopropenil*



1-butenil

*triviális nevek

HOMOLÓG SOR

etén (etilén)



propén (propilén)



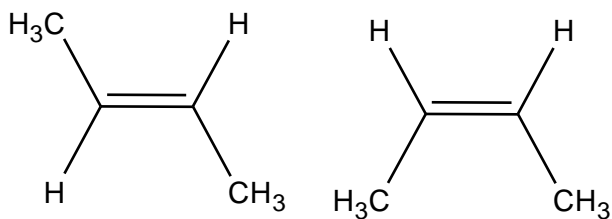
butén



:



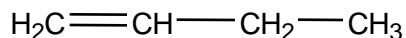
geometriai izoméria



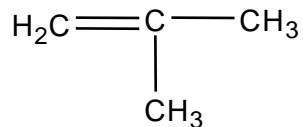
transz-2-butén

cisz-2-butén

strukturális izoméria



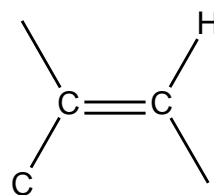
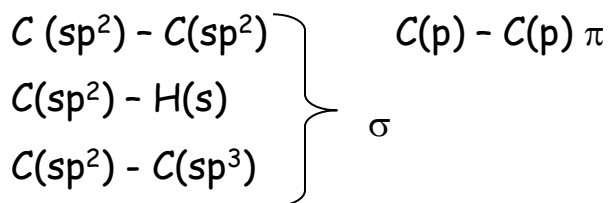
1-butén



2-metil-propén

Az alkének szerkezete

Kötésmód



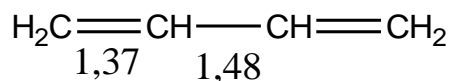
Kötéshossz

$$r[C(sp^2) - C(sp^2)] = 1,34 \text{ \AA}$$

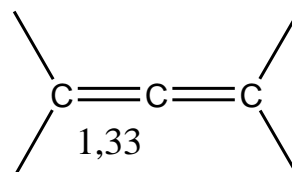
$$r[C(sp^2) - H(s)] = 1,10 \text{ \AA}$$

$$r[C(sp^2) - C(sp^3)] = 1,54 \text{ \AA}$$

De: a $r[C(sp^2) - C(sp^2)]$
[konjugált]



b $r[C(sp^2) - C(sp^2)]$
[kumulált dién]



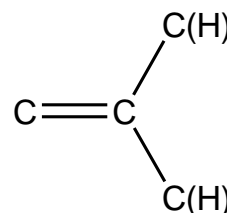
Kötésszög

$$CCC \quad \nearrow \quad 120^\circ$$

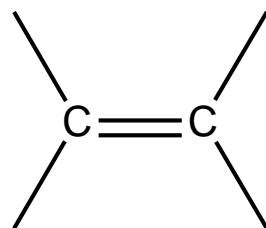
$$HCH \quad \nearrow \quad 116,7^\circ$$

$$HCC \quad \nearrow \quad 121,6^\circ$$

} szögfeszültség



Kötési energia



540 kJ/mol

Konfiguráció

Planáris

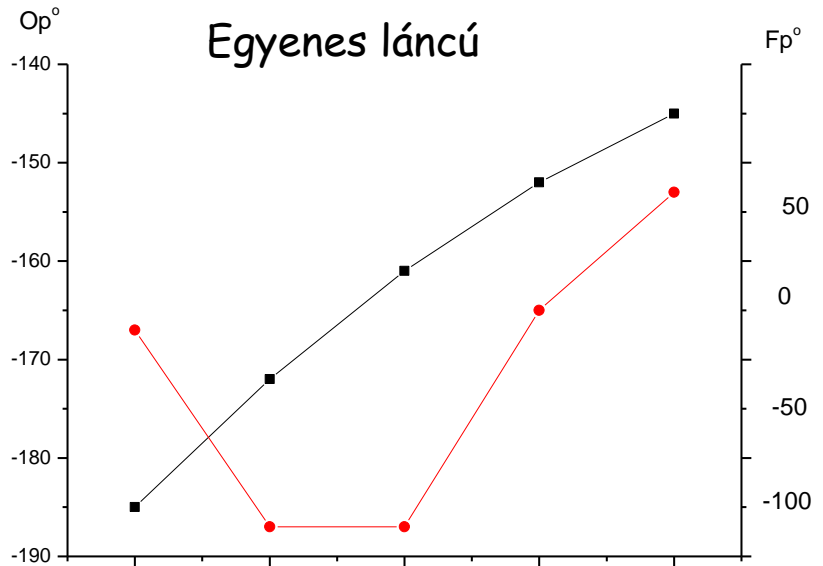
Konformáció

gátolt rotáció (lásd: geometriai izoméria)

Fizikai tulajdonságok

Halmazállapot

C_{2-4}	gáz
C_{5-7}	folyadék
C_{8-}	szilárd



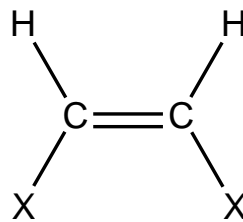
Cisz-transz izomerek

* Jobb illeszkedés, ** Jobb illeszkedés

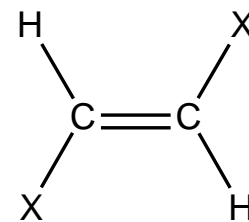
op	cisz	transz*	cisz	transz**	fp
2-butén	-139	-106	3,7	0,9	
2-pentén	-151	< -140	37,9	> 36,4	
2-hexén	-141	-133	68,8	67,9	

Dipólusmomentum

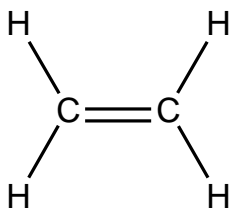
AZONOSITÁS



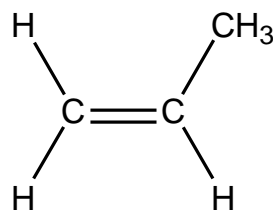
$\mu > 0$ [cisz]



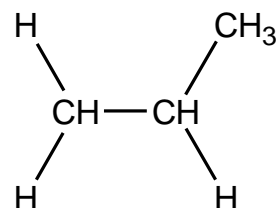
$\mu = 0$ [transz]



$\mu = 0$



$\mu = 0,4$



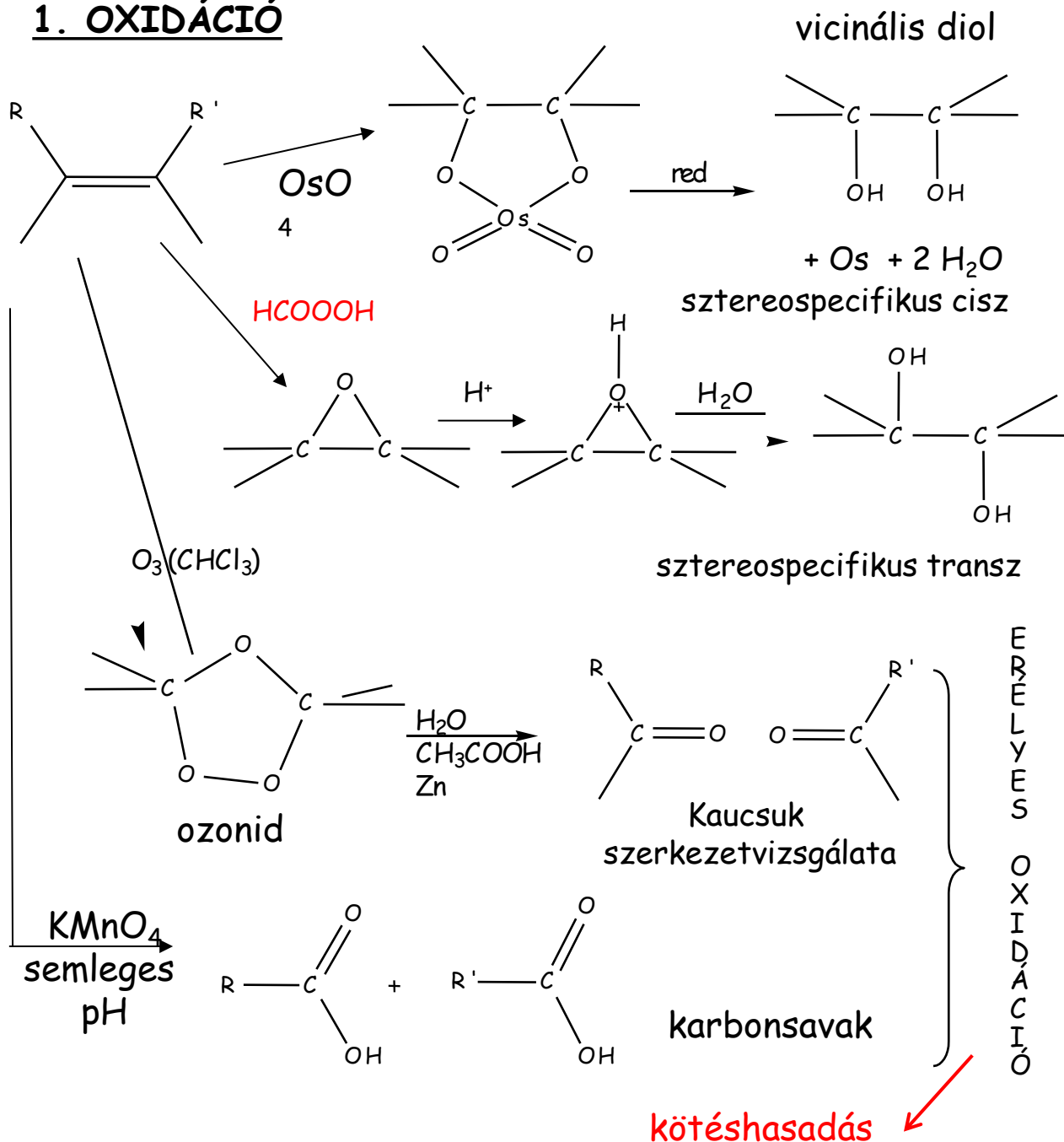
$\mu = 0$

OKA: $C(sp^2) > C(sp^3)$ EN

Alkének reakciói

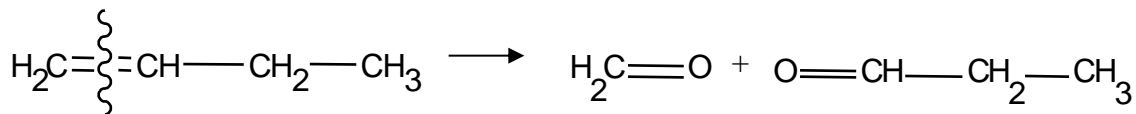
1. Oxidáció
2. Redukció - hidrogénezés
3. Elektrophil addíció - kumulált diénre-
- átrendeződéssel
- részleges addíció
4. Polimerizáció

1. OXIDÁCIÓ

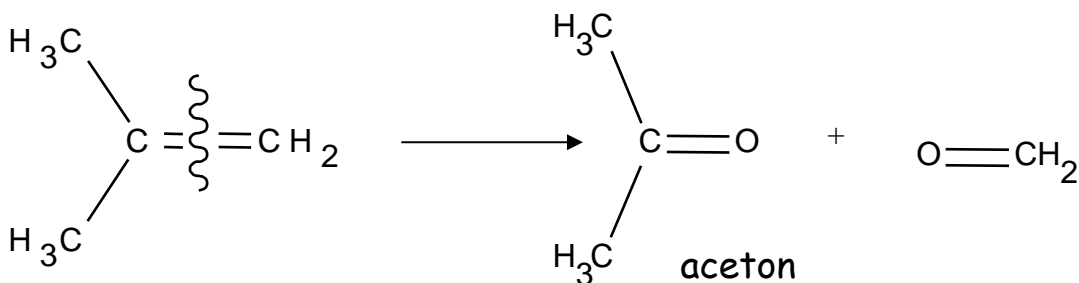
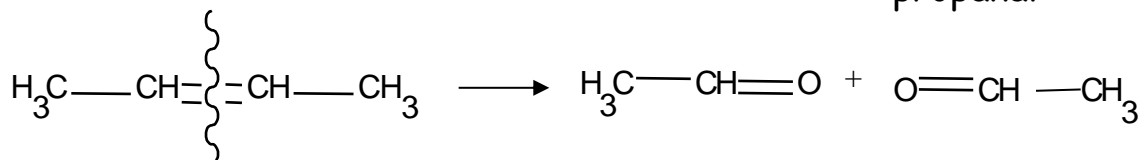


ALKALMAZÁS:

Szerkezetvizsgálat ozonidos lebontással (pl. kaucsuk)



propánal

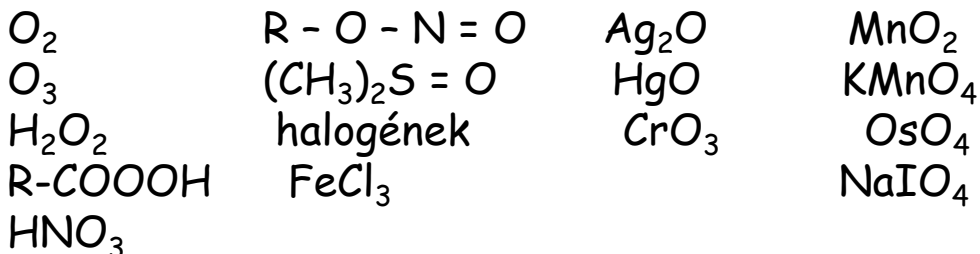


aceton

Kiterjesztés: poliének

Szerves kémiában használt oxidáló/redukáló szerek

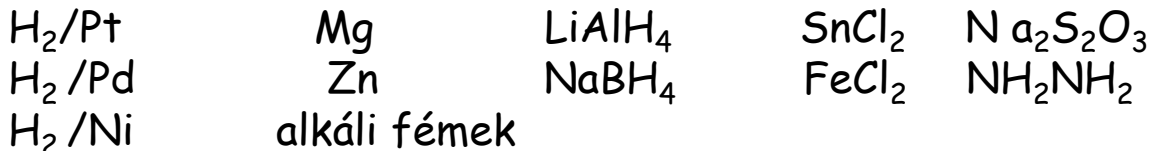
Oxidáló szerek



Dehidrogénező szerek

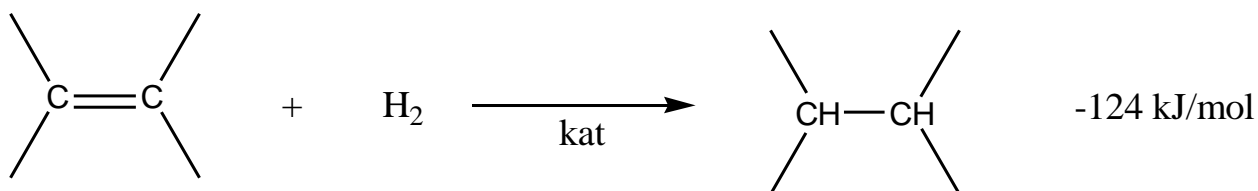
Pt, Pd, S, Se

Redukáló szerek



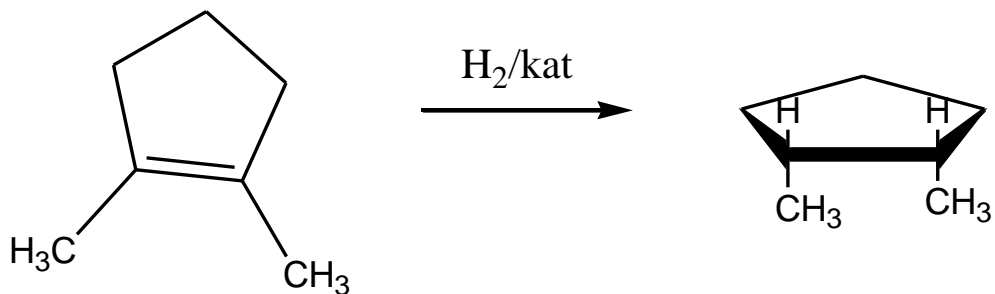
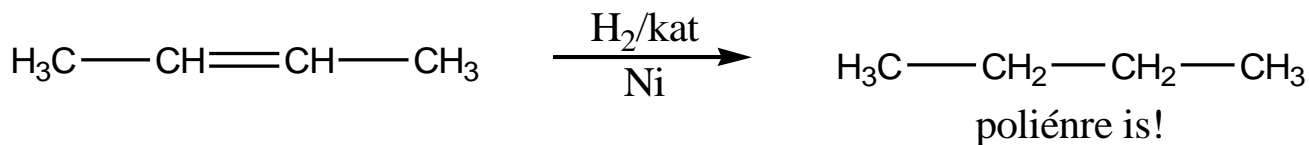
2. REDUKCIÓ - HIDROGÉNEZÉS

SZTEREOSPECIFIKUS CISZ ADDÍCIÓ (Ad_E)



Példa:

cisz/transz



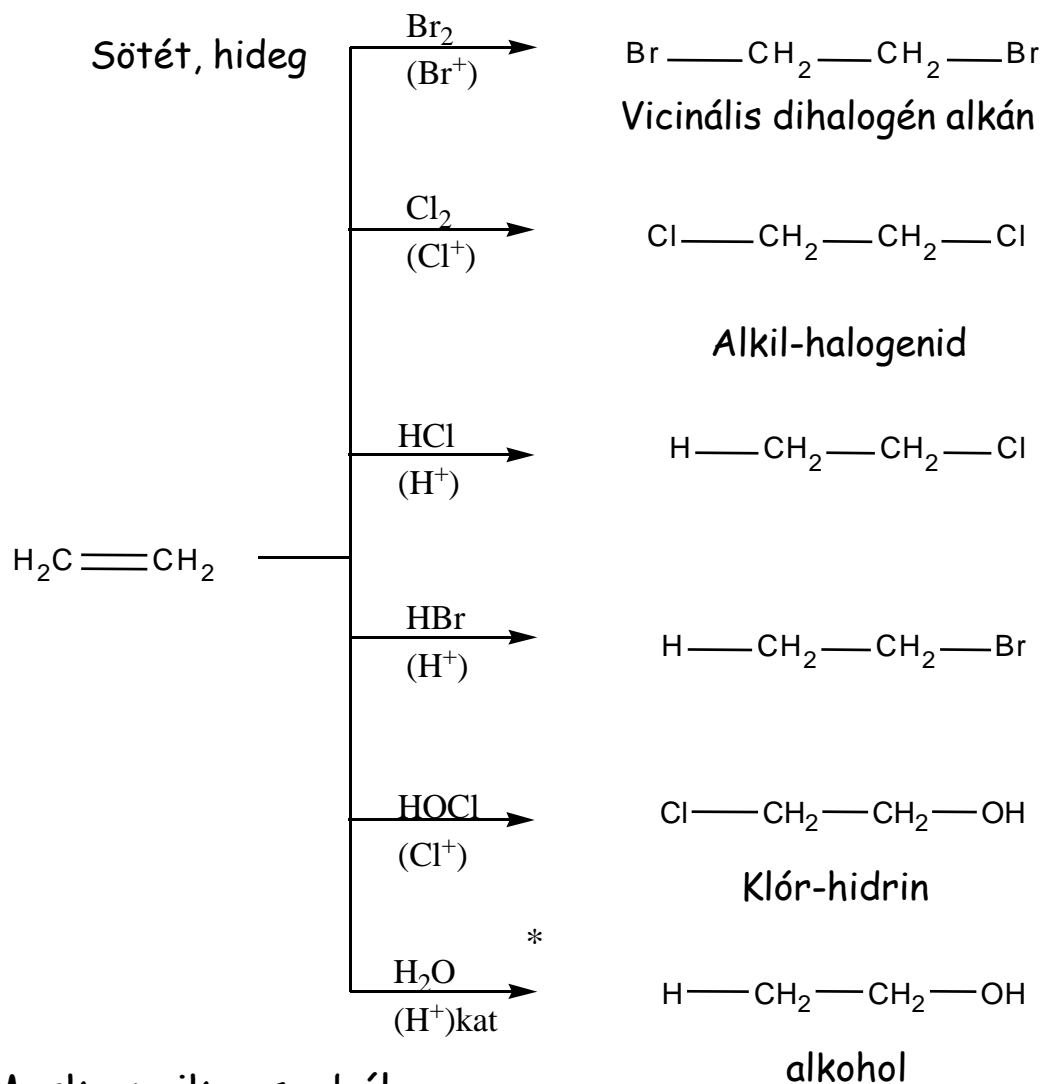
1,2-dimetil-1-ciklopentén

mezo-1,2-dimetil-ciklopentán

Alkalmazás: Telítetlen kötések számának meghatározása

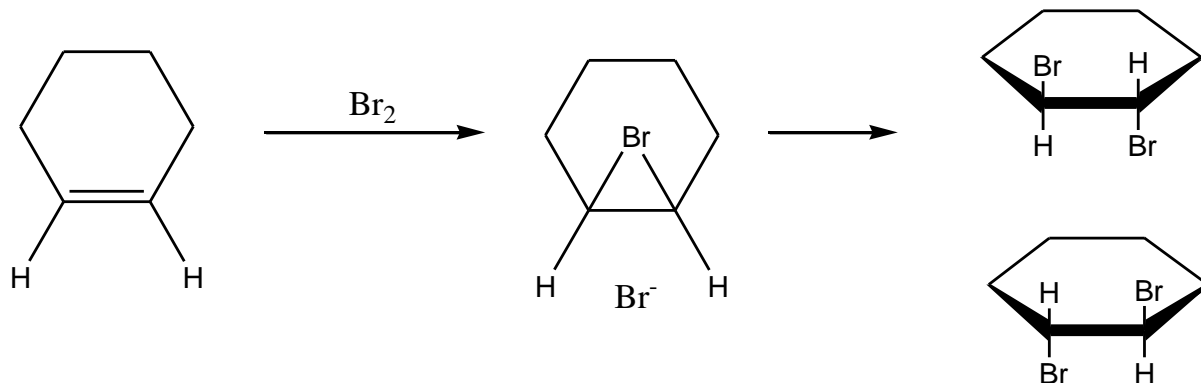
1 mmol olefinkötés 22,4ml normál H_2 gázt fejleszt

3. ELEKTROFIL ADDÍCIÓ (Ad_E)



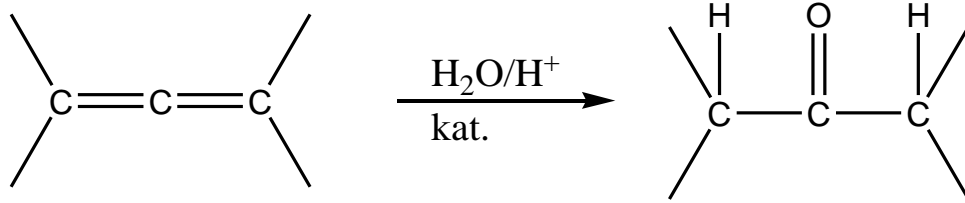
*Markovnyikov szabály

Példa: Transz-addíció \longrightarrow enantiomerek racemátja

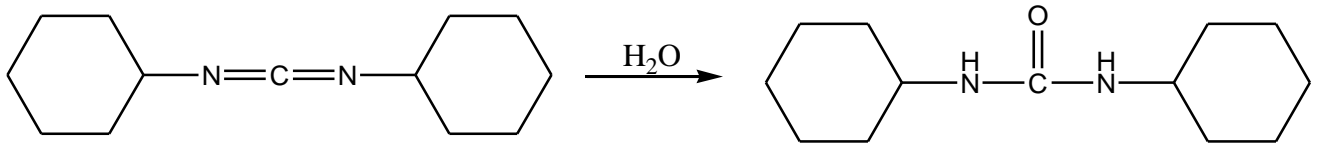


H₂O ADDÍCIÓ KUMULÁLT DIÉNRE

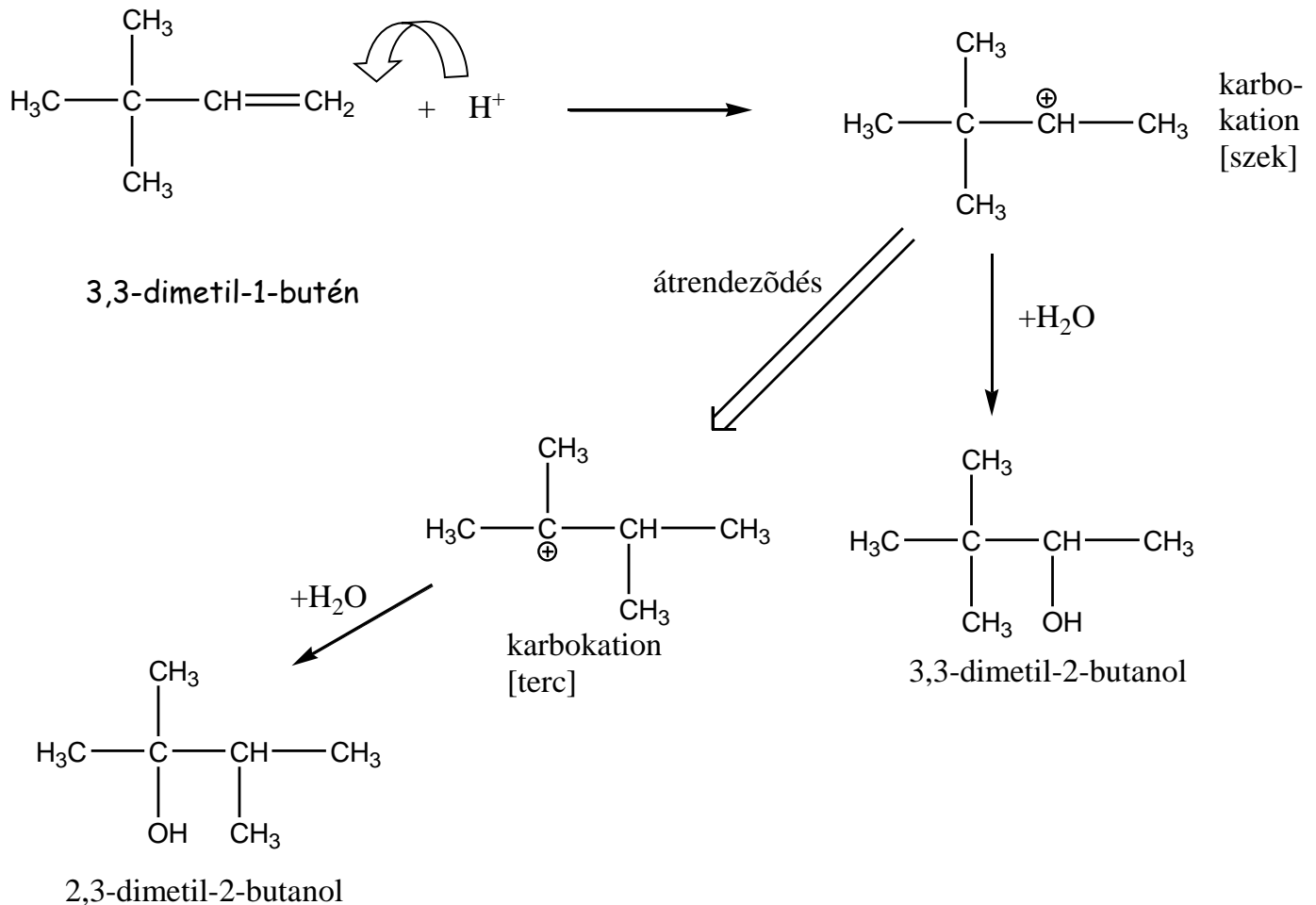
a.



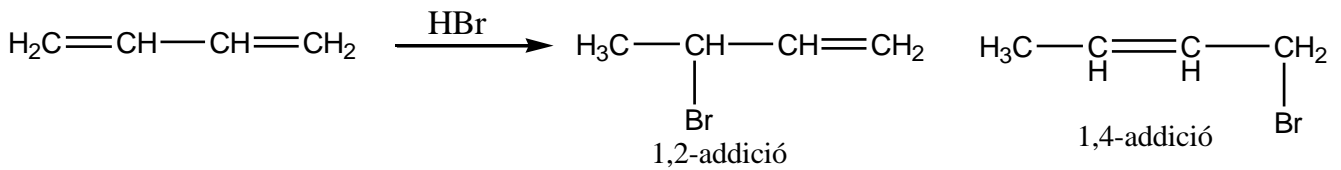
b.



ADDÍCIÓ ÁTRENDEZŐDÉSSEL

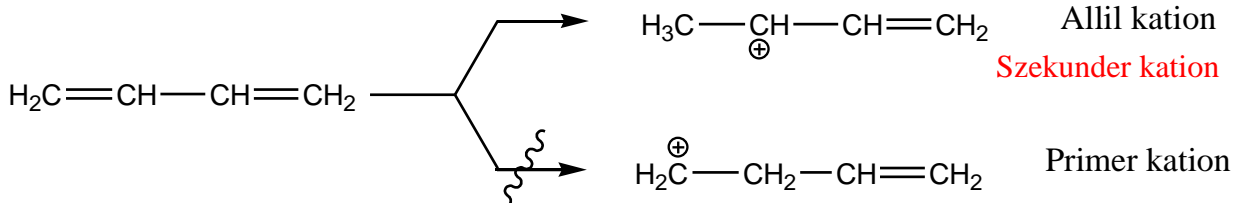


RÉSZLEGES ELEKTROFIL ADDÍCIÓ

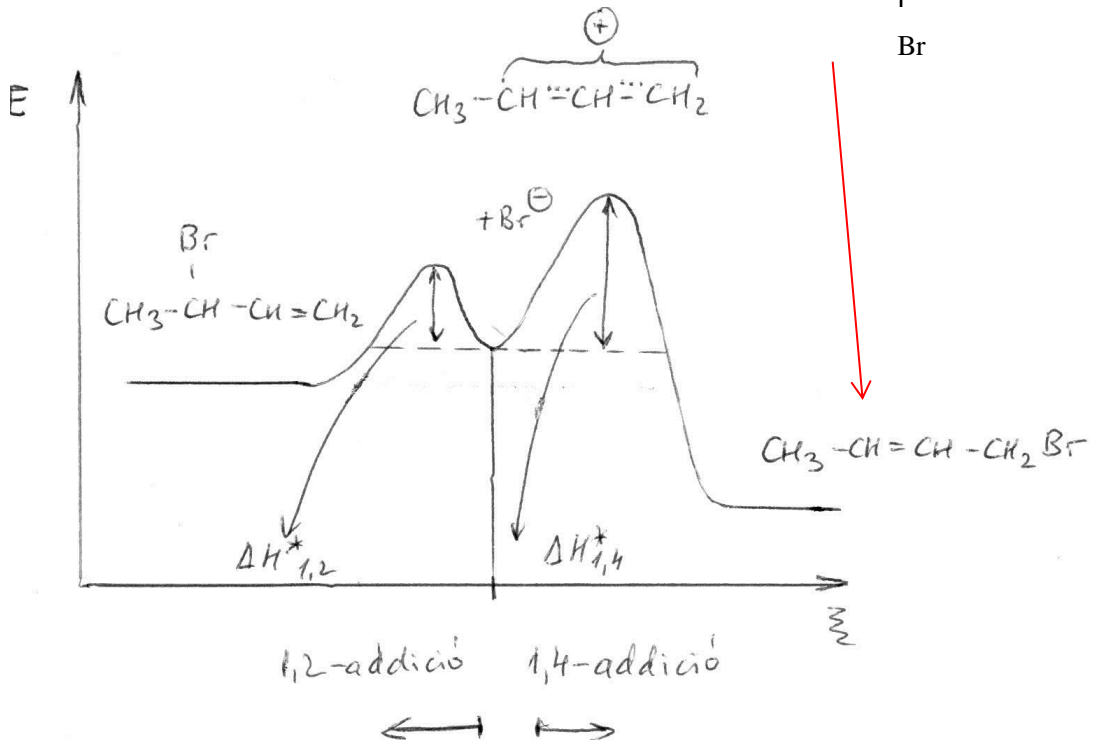
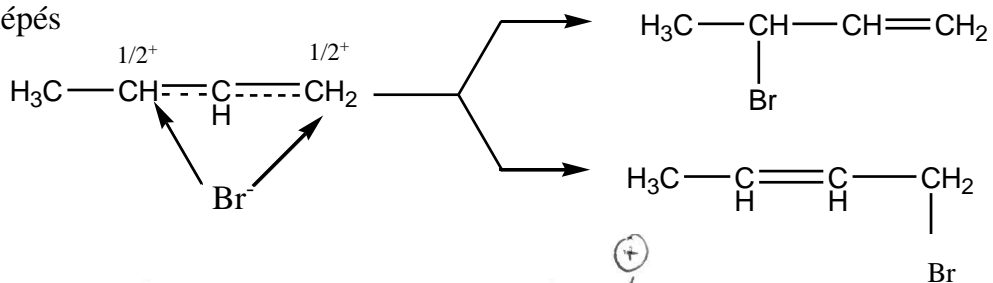


Mechanizmus:

1. lépés

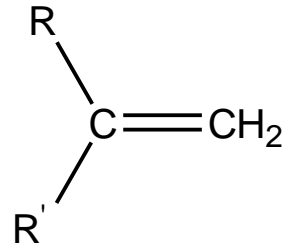


2. lépés



POLIMERIZÁCIÓ

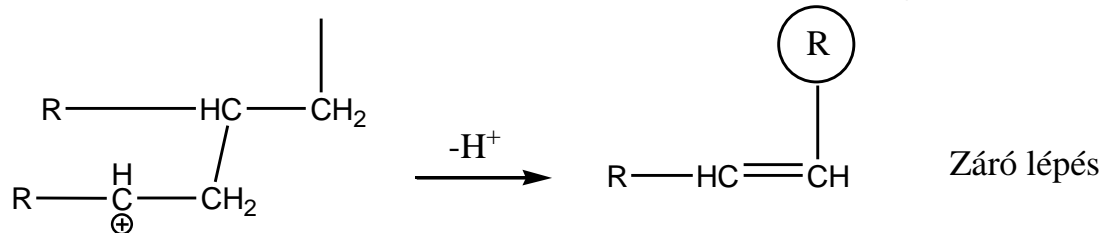
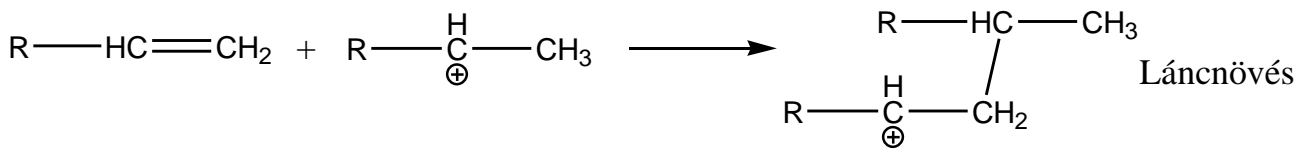
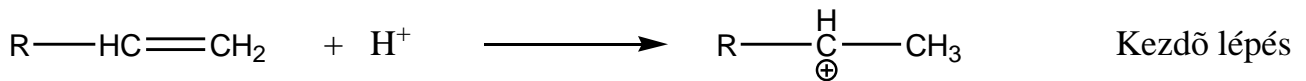
Poliaddíció



R	R'	Alapvegyület	Polimer
H	H	Etilén	Polietilén
H	CH ₃	Propilén	Polipropilén
H	Cl	Vinil-klorid	PVC
H	C ₆ H ₅	Sztirol	Polisztirol
H	OCOCH ₃	Vinil-acetát	Poli(vinil-acetát)

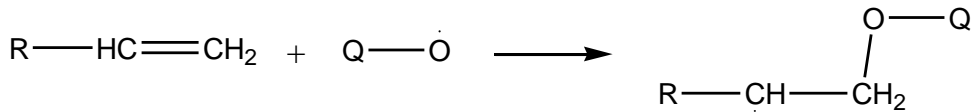
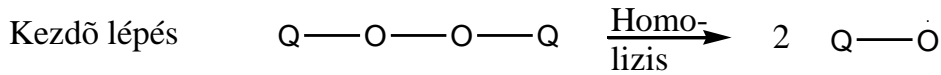
Mechanizmus:

A. Kationos [savkatalizált - HF, H₂SO₄]

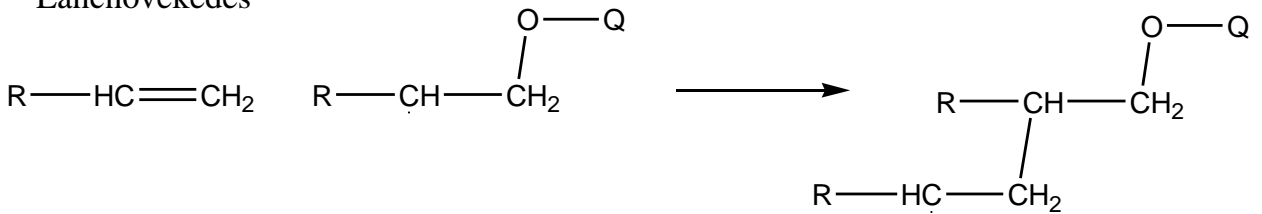


Pl.: Poliizobutilén

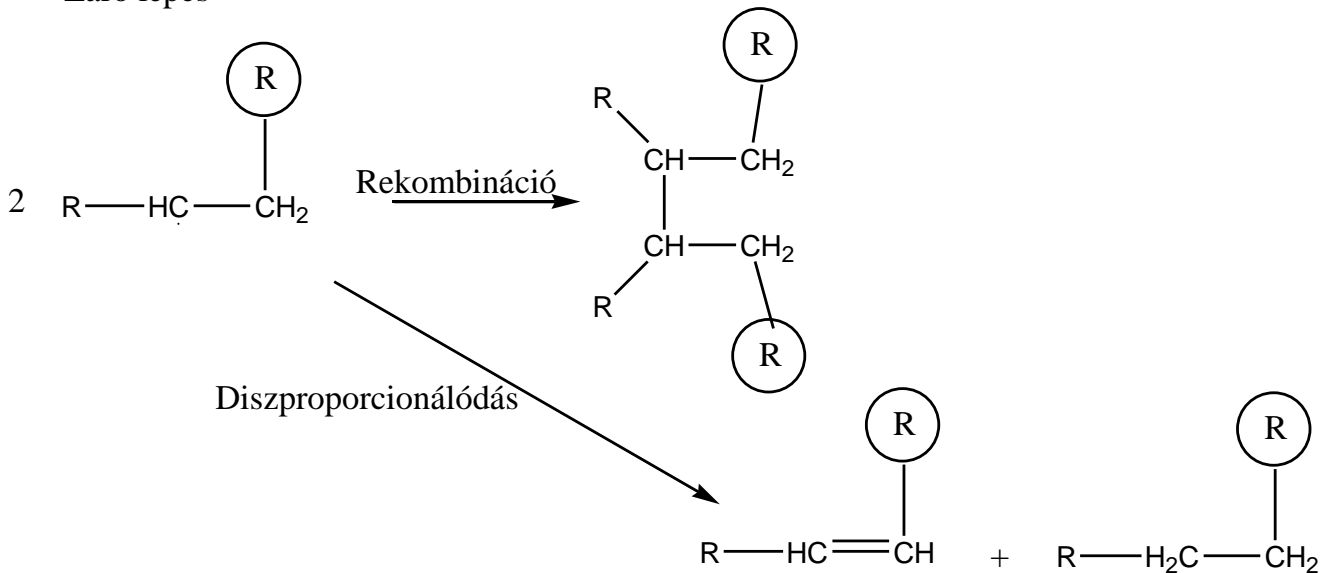
B. Gyökös (iniciátor)



Láncnövekedés

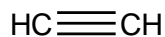


Záró lépés

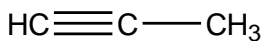


Példa: polivinilalkohol
polisztirol

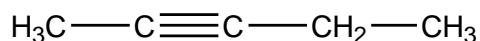
19.3 ALKINEK, CIKLOALKINEK



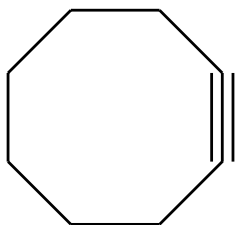
acetilén (etin)



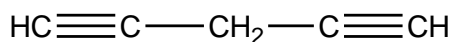
propin
(metil-acetilén)



2-pentin



ciklooktin

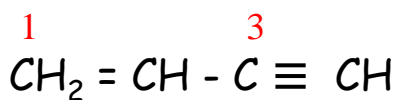


1,4-pentadiin

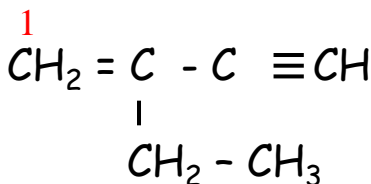
Nomenklatura:

a) kettős kötés „erősebb”, mint a hármas

b) leghosszabb szén lánc, amelyben az összes telítetlen kötés van



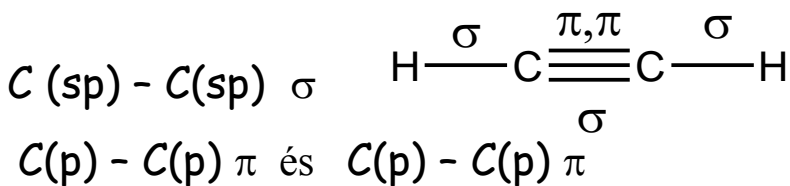
1-butén-3-in



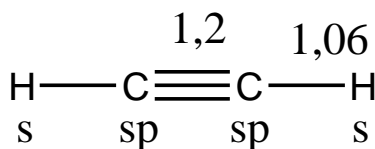
2-etil - 1-butén-3-in

DE nem: „pent-1-in”

Kötésmód



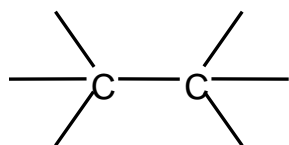
Kötéshossz



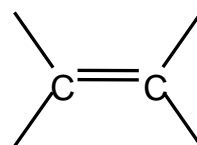
Kötésszög



Kötési energia



360 kJ/mol

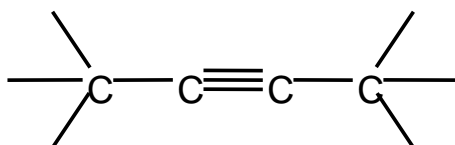


540 kJ/mol



670 kJ/mol

Konfiguráció



lineáris

ALKINEK REAKCIÓI

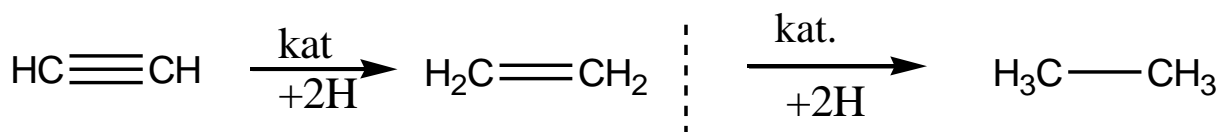
1. SAV-BÁZIS REAKCIÓ



Disszociációs állandók

CH_3COOH	O-H sav	pK_a 4,76	↑ Savi jelleg
H_2O	O-H sav	15,7	
$\text{HC}\equiv\text{CH}$	C-H sav	25,0	
NH_3	N-H sav	35,0	
$\text{H}_2\text{C}=\text{CH}_2$	C-H sav	36,0	
$\text{H}_3\text{C}-\text{CH}_3$	C-H sav	42,0	

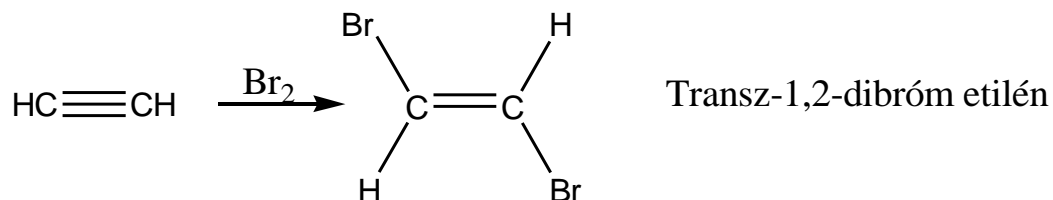
2. REDUKCIÓ - HIDROGÉNEZÉS



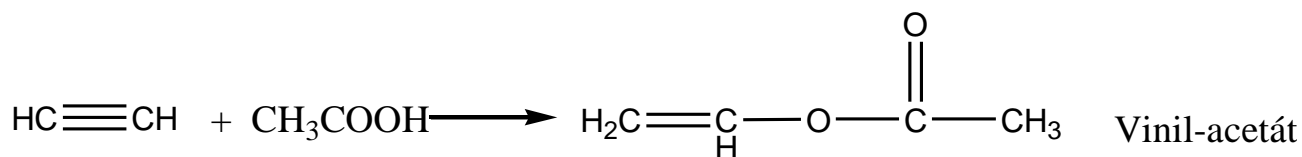
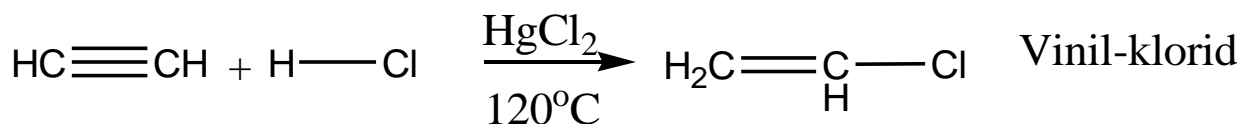
Katalizátor: a) fém Zn/NaOH nascens H

b) fém Na/NH₃ transz, részleges

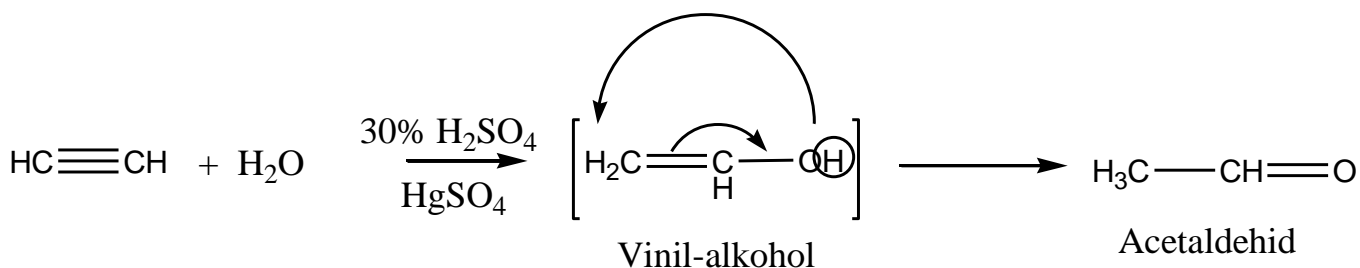
3. HALOGÉNEZÉS



4. SAVADDICIÓ (A_E): (pl. X-H, O-H sav)



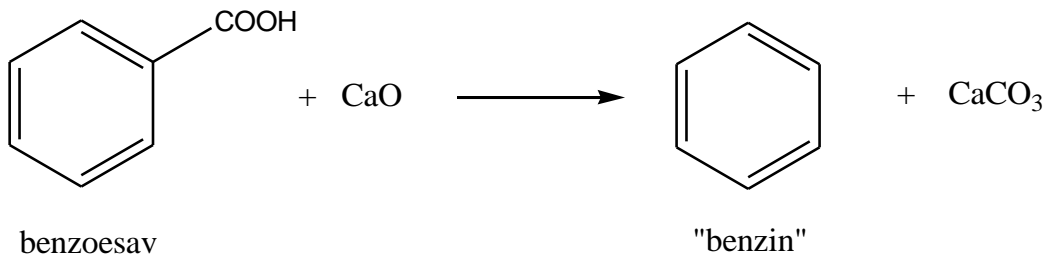
5. VÍZADDICIÓ (A_N) és ÁTRENDEZŐDÉS



enol - keto

19.4. Arének

Benzol, felfedezés, 1825 Michael Faraday ;
előállítás, 1934 Eilhard Mitscherlich (benzin)



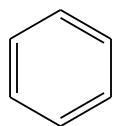
Benzoe gyanta (Gummi benzoë) - szagtalan

Styrax - fák kérge \longrightarrow balzsam

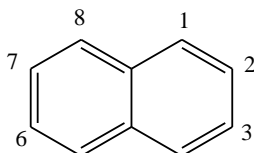
Szumatra - benzoe „in lacirmis” (könnyek), (fahéjsav, vanillin) „in massa”

A. W. Hofmann, szénkátrányból (1845), petroleumból (1950)

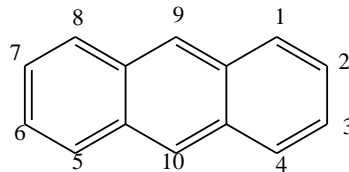
Példák:



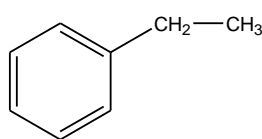
benzol



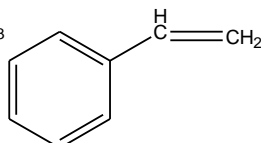
naftalin



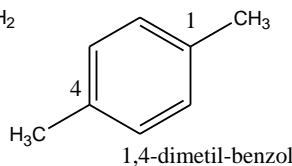
antracén



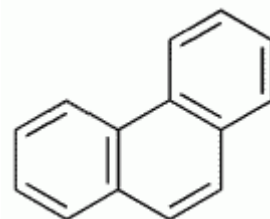
etil-benzol



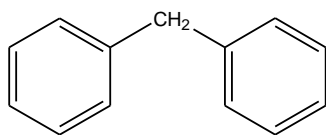
sztirol



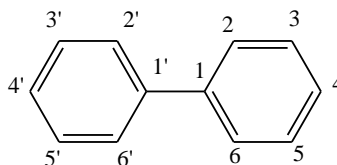
1,4-dimetil-benzol



fenantrén

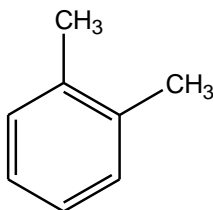


difenil-metán

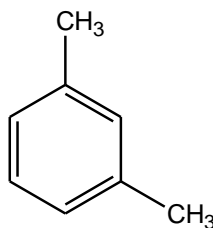


bifenil

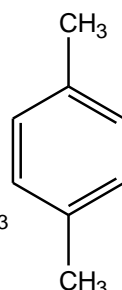
Xilol



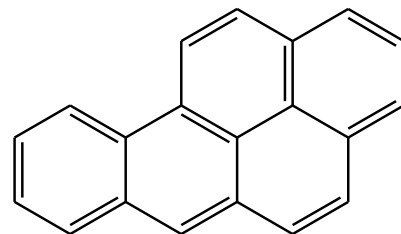
1,2-dimetil-benzol
orto



1,3-dimetil-benzol
meta



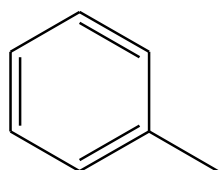
1,4-dimetil-benzol
para



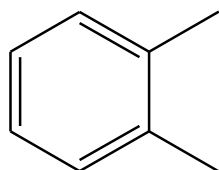
benzo[a]pirén

1775: Sir Percival Pott

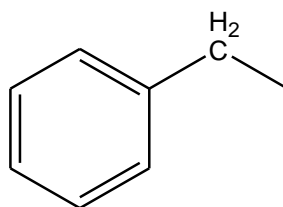
Csoportnevek



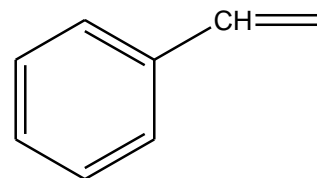
fenil



1,2-fenilén

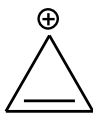


benzil

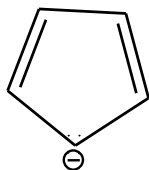


benzál

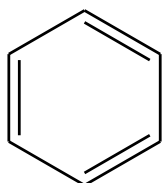
Homológ sor $[4n+2]$



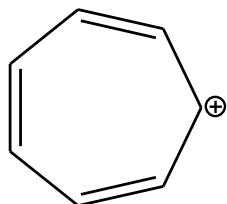
ciklopropenilium kation



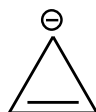
ciklopentadienát anion



benzol



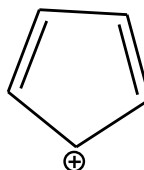
cikloheptatrienilium kation



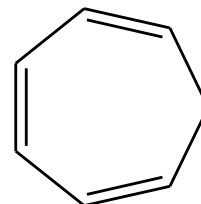
4



4

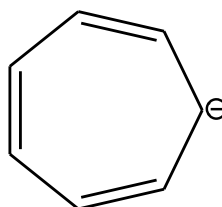


4

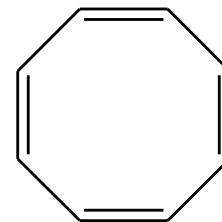


6

*



8

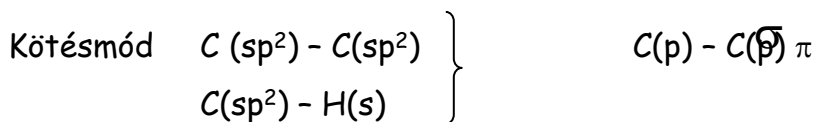


8

HÜCKEL-SZABÁLY

* Nem planáris

Az arének szerkezete



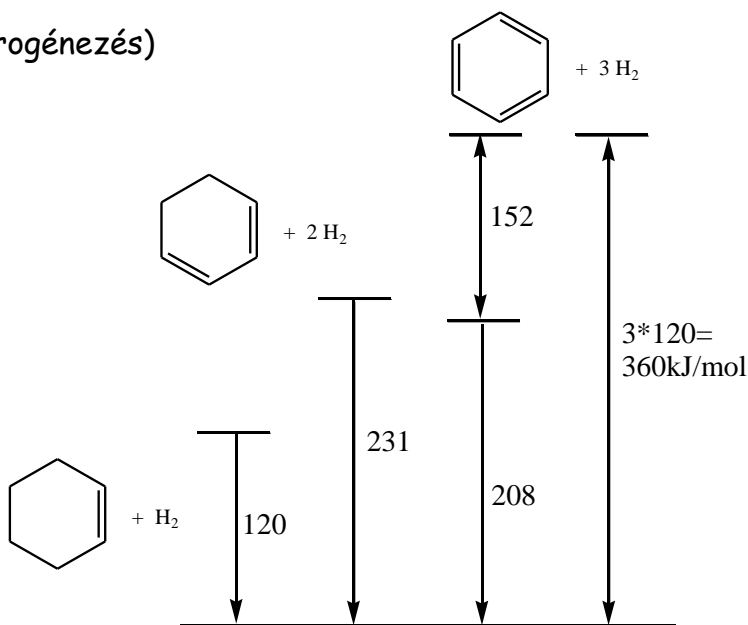
ciklusosan konjugált rendszer

Kötéshossz $r[C(sp^2) - C(sp^2)] = 1,39 \text{ \AA}$

Kötésszög $CCC \curvearrowright 120^\circ$ } Konfiguráció: plenáris gyűrű
 $HCC \curvearrowright 120^\circ$ }

Nincs szögfeszültség

Kötési energia (példa: hidrogénezés)



Fizikai tulajdonságok

Halmazállapot

	op [°C]	fp [°C]		op [°C]	fp [°C]
Benzol	5,5	80	Toluol	-95	111
Naftalin	80	218	o-xilol	-25	144
Antracén	217	340	m-xilol	-48	139
Fenantrén	99	340	p-xilol	13	138

(Bonyolultsággal nő az fp.)

Oldékonyság: Hasonló hasonlót old.

Arének reakciói

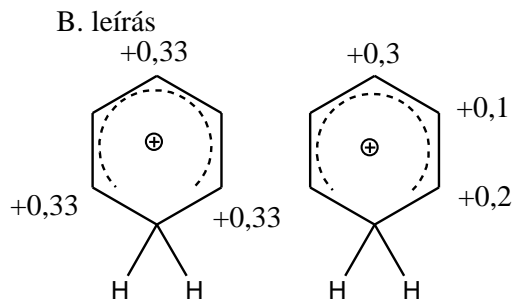
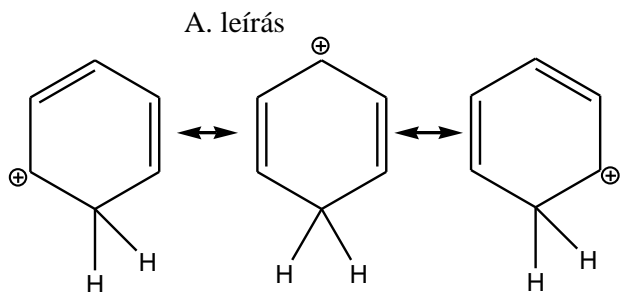
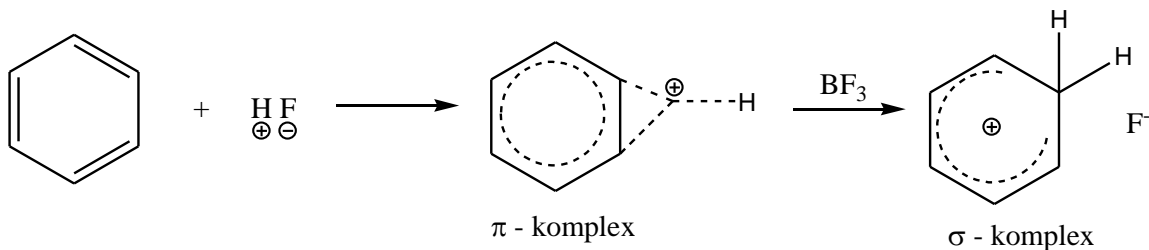
Aromás magon

Oldalláncon

1. Sav-bázis reakció
2. Oxidáció
3. Redukció-hidrogénezés
4. Addíció
5. Elektrofil szubsztitúció

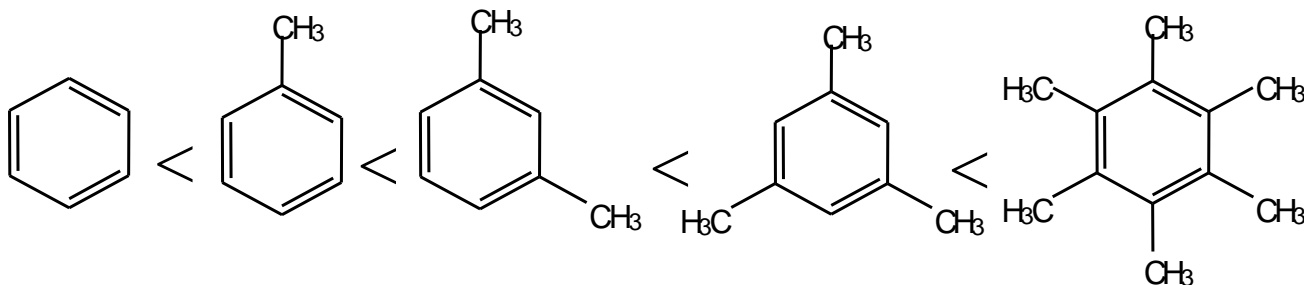
Oxidáció

1. SAV-BÁZIS REAKCIÓ



„Aktív” helyek: para > orto > meta

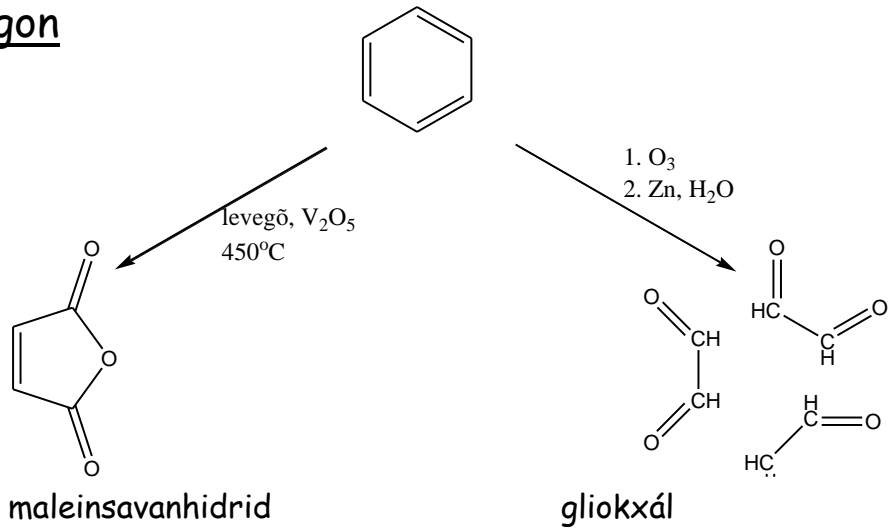
Relatív bázikusság: (+ I effektus - alkil csoport)



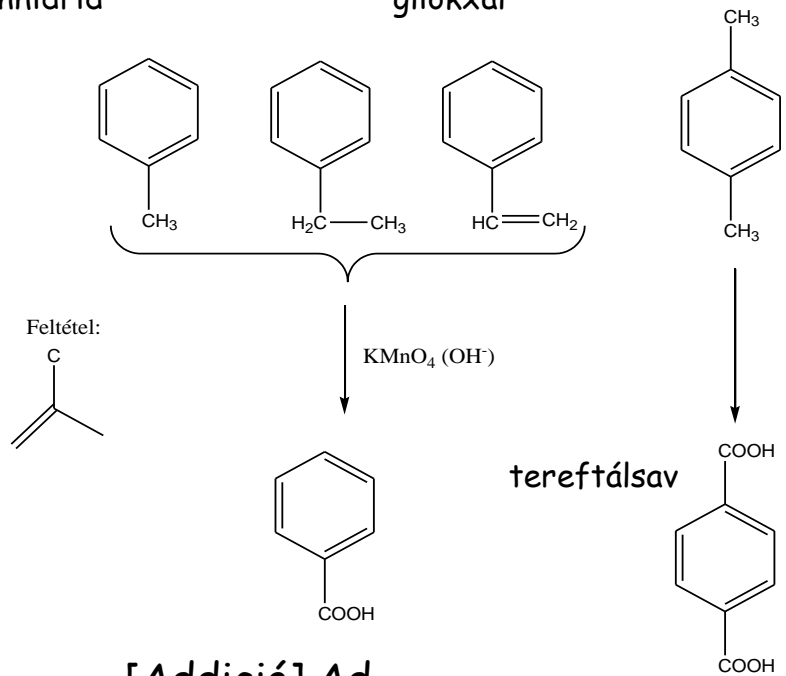
2. OXIDÁCIÓ

NEM: Cr_2O_3 , OsO_4 , H_2O_2 , KMnO_4

Aromás magon

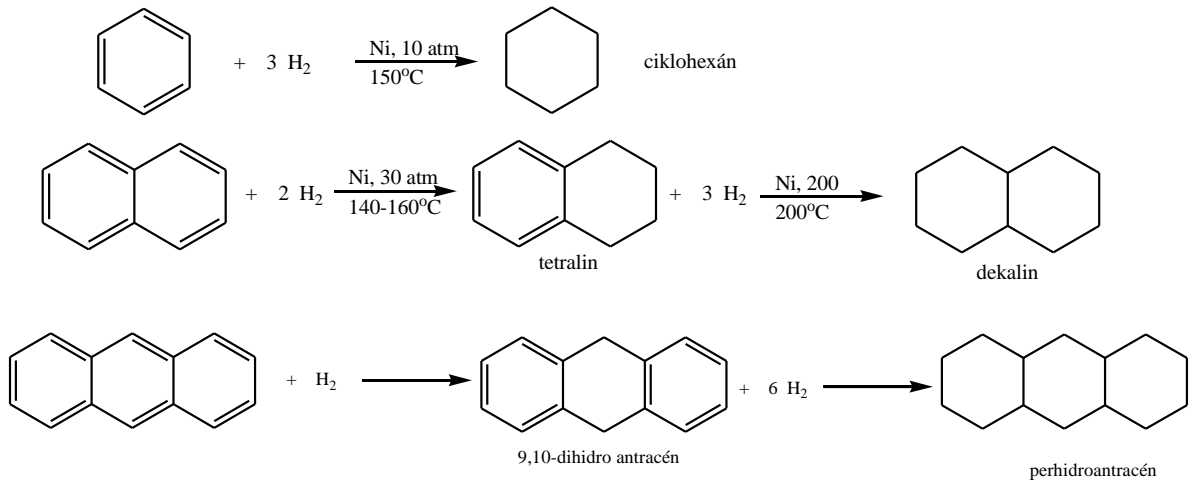


Oldalláncon

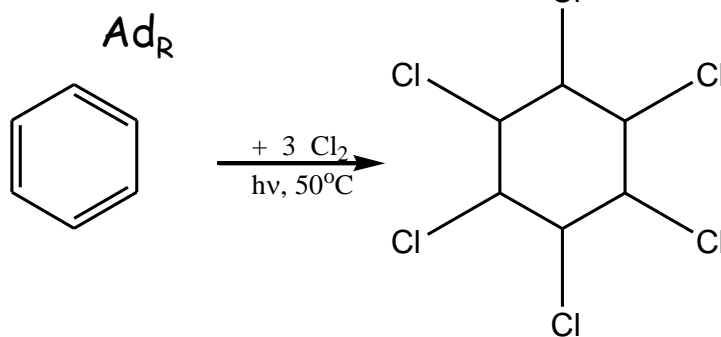


3. HIDROGÉNEZÉS

[Addíció] Ad_E

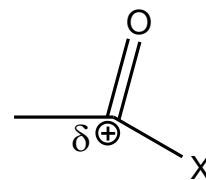


4. ADDÍCIÓ

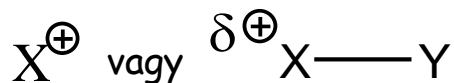


5. ELEKTROFIL SZUBSZTITÚCIÓ, S_E

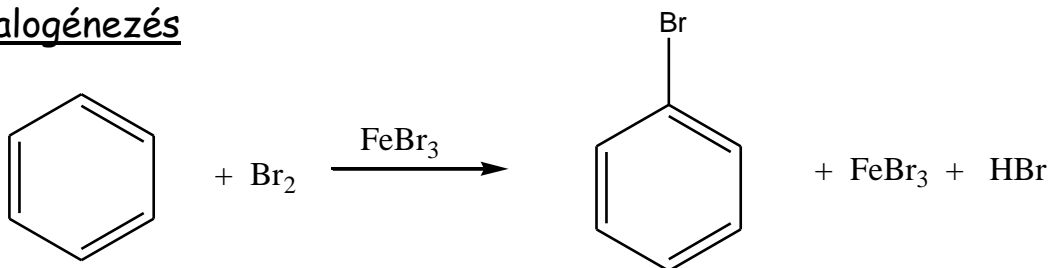
- I. Halogénezés X^\oplus
- II. Nitrálás NO_2^\oplus
- III. Szulfonálás SO_3^\oplus
- IV. Friedel-Crafts alkilezés R^\oplus
- V. Friedel-Crafts acilezés



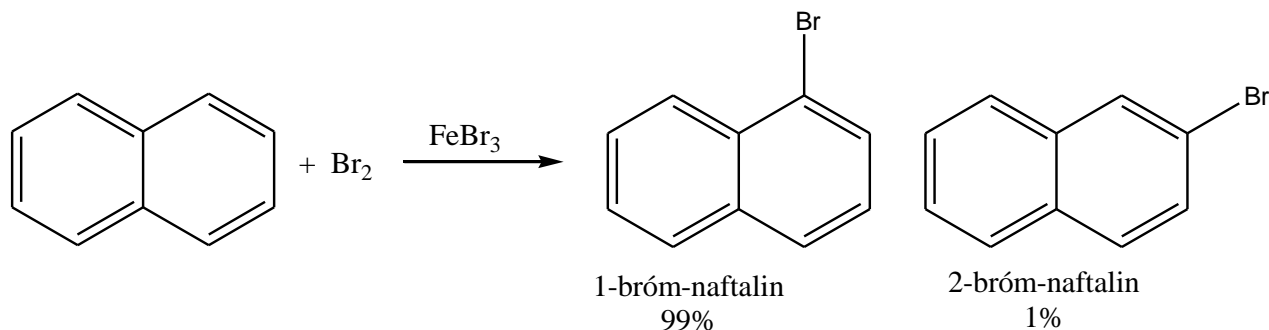
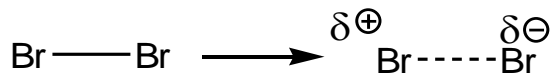
Elektrofilek



5.1. Halogénezés



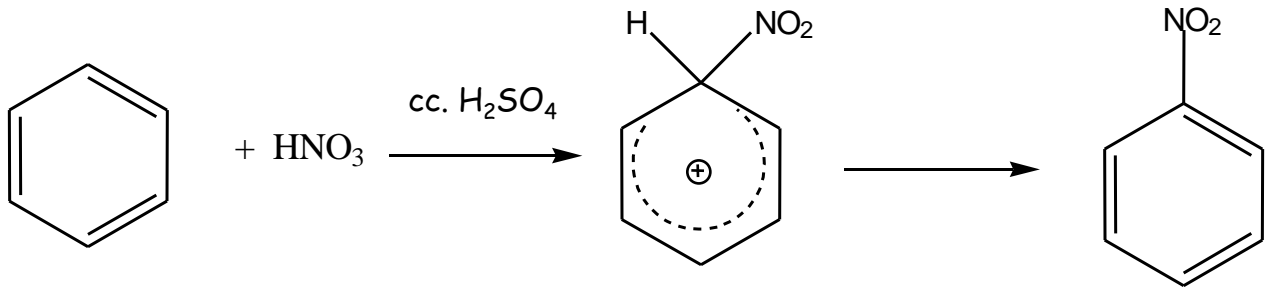
Katalizátor (FeCl_3 , AlCl_3 , ZnCl_2) szerepe:



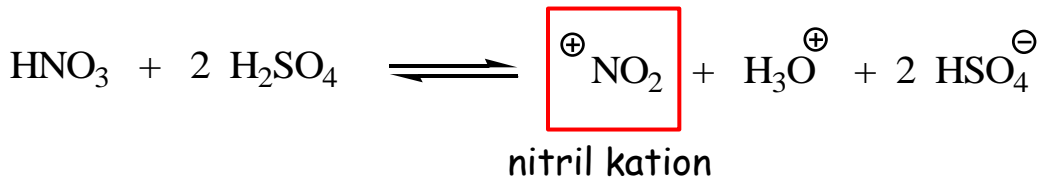
Megjegyzés:



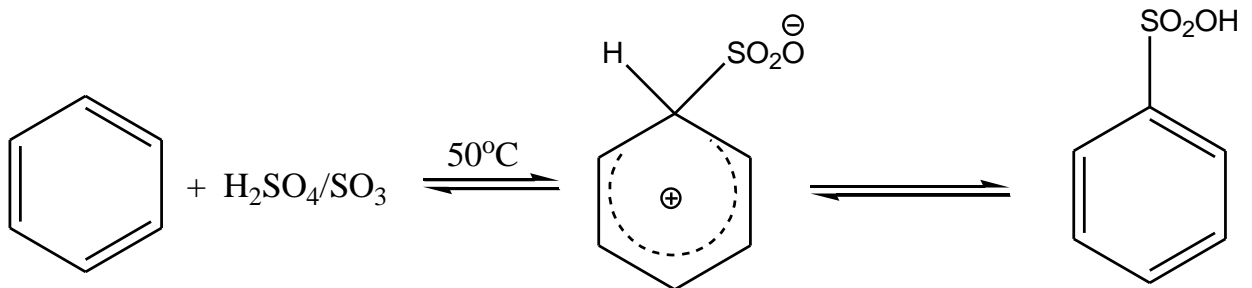
5.2. Nitrálás



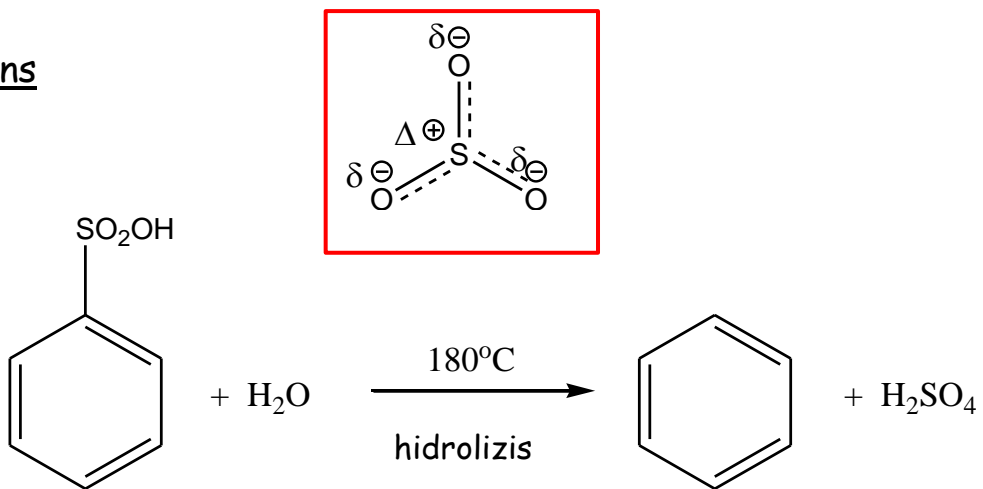
Reagens:



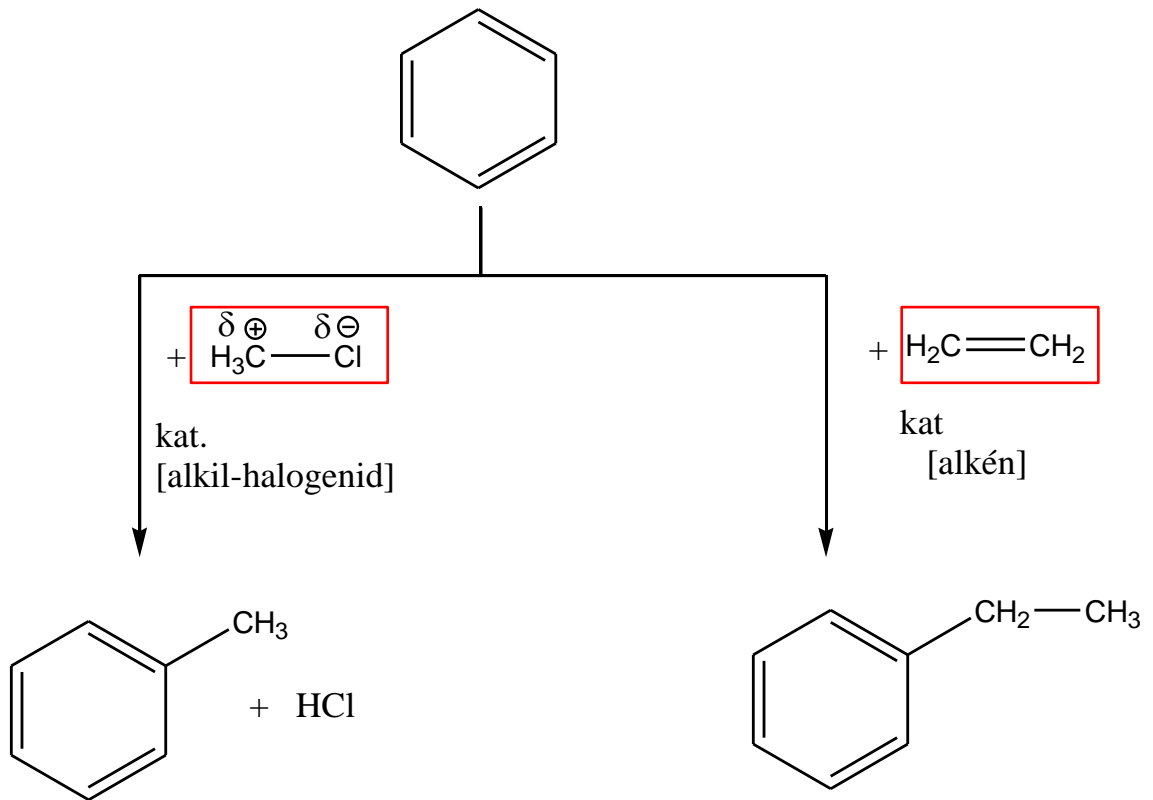
5.3. Szulfonálás



Reagens

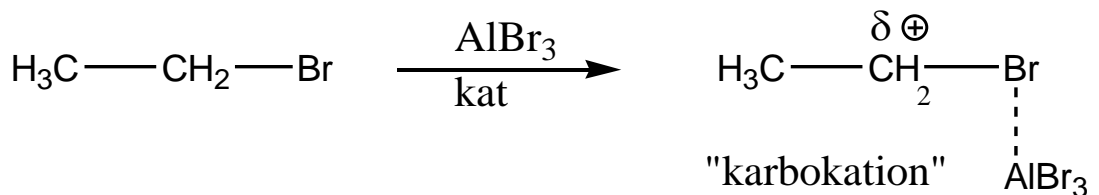


5.4. Friedel-Crafts alkilezés



A. Alkil-halogenid: kat. AlCl_3 , AlBr_3 , SbCl_5 , BF_3

Reagens:



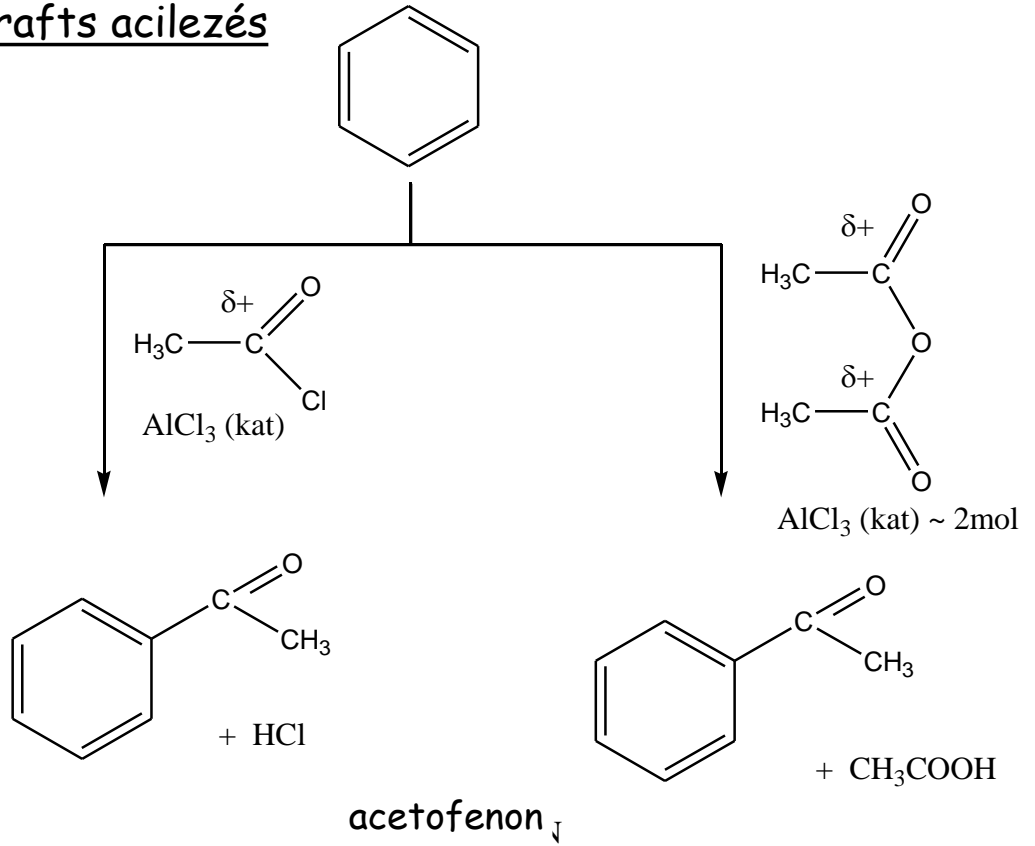
Reaktivitás: terciér > szekunder > primer

$\text{R-F} > \text{R-Cl} > \text{R-Br} > \text{R-I}$

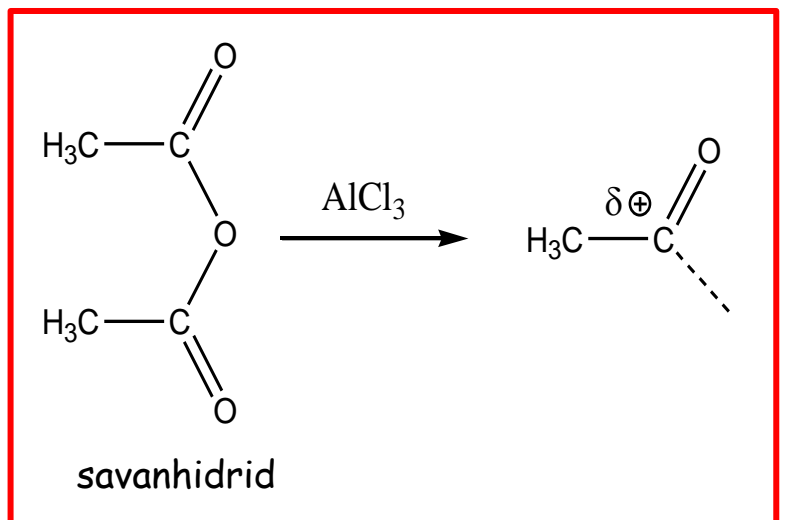
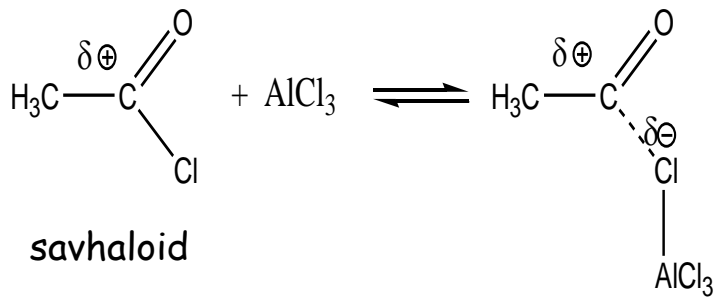
B. Alkén: kat. sav (pl. H_3PO_4)

Reagens: karbokation ($\text{CH}_2 = \text{CH}_2 + \text{H}^+ \rightarrow \text{CH}_3 - \text{CH}_2^+$)

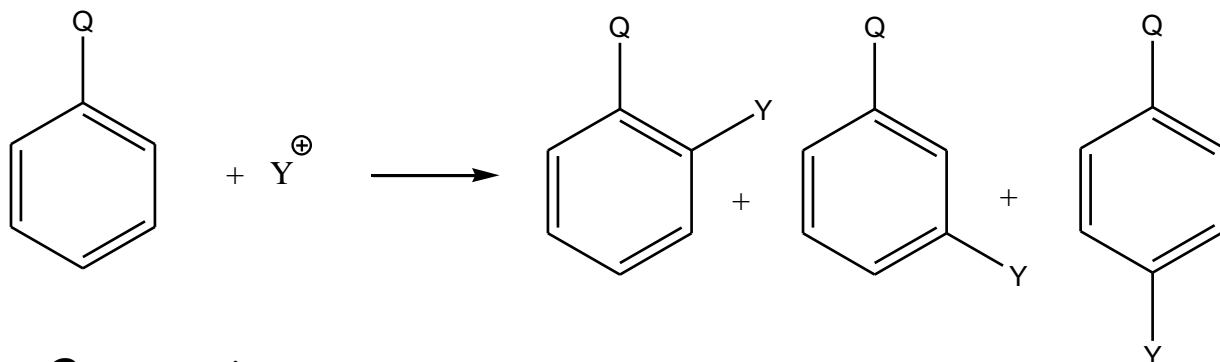
5.5. Friedel-Crafts acilezés



Reagensek



OLDALLÁNC HATÁSA AZ S_E REAKCIÓRA



a Q csoport szerepe:

1. Fokozhatja/csökkentheti **a mag reakcióját** a benzolhoz viszonyítva.
2. Befolyásolhatja Y beépülésének **helyét** → irányít.

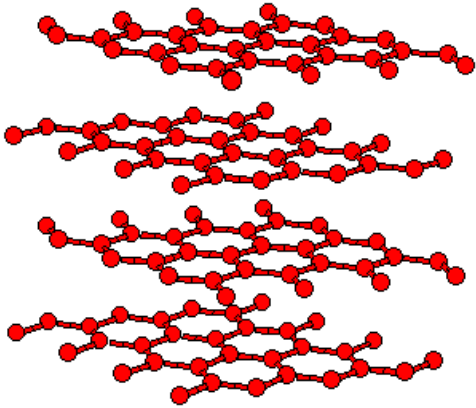
Q lehet: 1. Aktiváló - dezaktiváló

2. Irányító pozíció: orto, para, meta

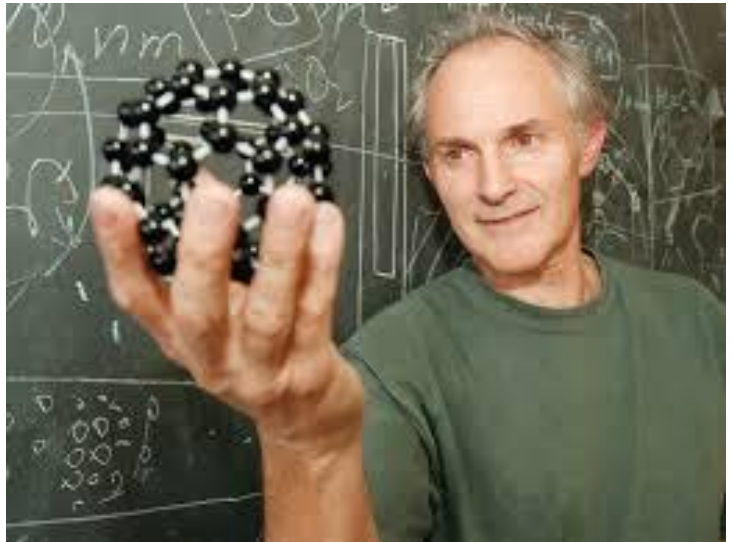
Aktiváló	Dezaktiváló	
orto, para	orto, para	meta
-OH	-F, Cl, Br, I	-NO ₂ , -NH ⁺ (CH ₃) ₂
-OR, OAr	-CH ₂ Cl	-COOH
-NH ₂ , NHR		-COOR, -CN
-R, -Ar, -CHCH ₂		-CHO, -CRO
Növelik a gyűrű reaktivitását, legjobban az o,p pozícióban	Csökkentik a gyűrű reaktivitását, legkevésbé az o, p pozícióban	Csökkentik, de legkevésbé a m pozícióban

C₆₀ KLASZTER

H. W. Kroto, R. E. Smalley (1984, Nobel díj 1996, R.F. Curl)

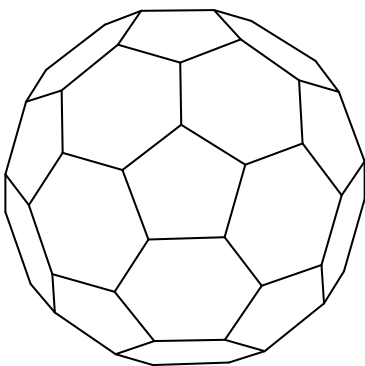


GRAFIT



Lézer

C₆₀



R. Buckminster

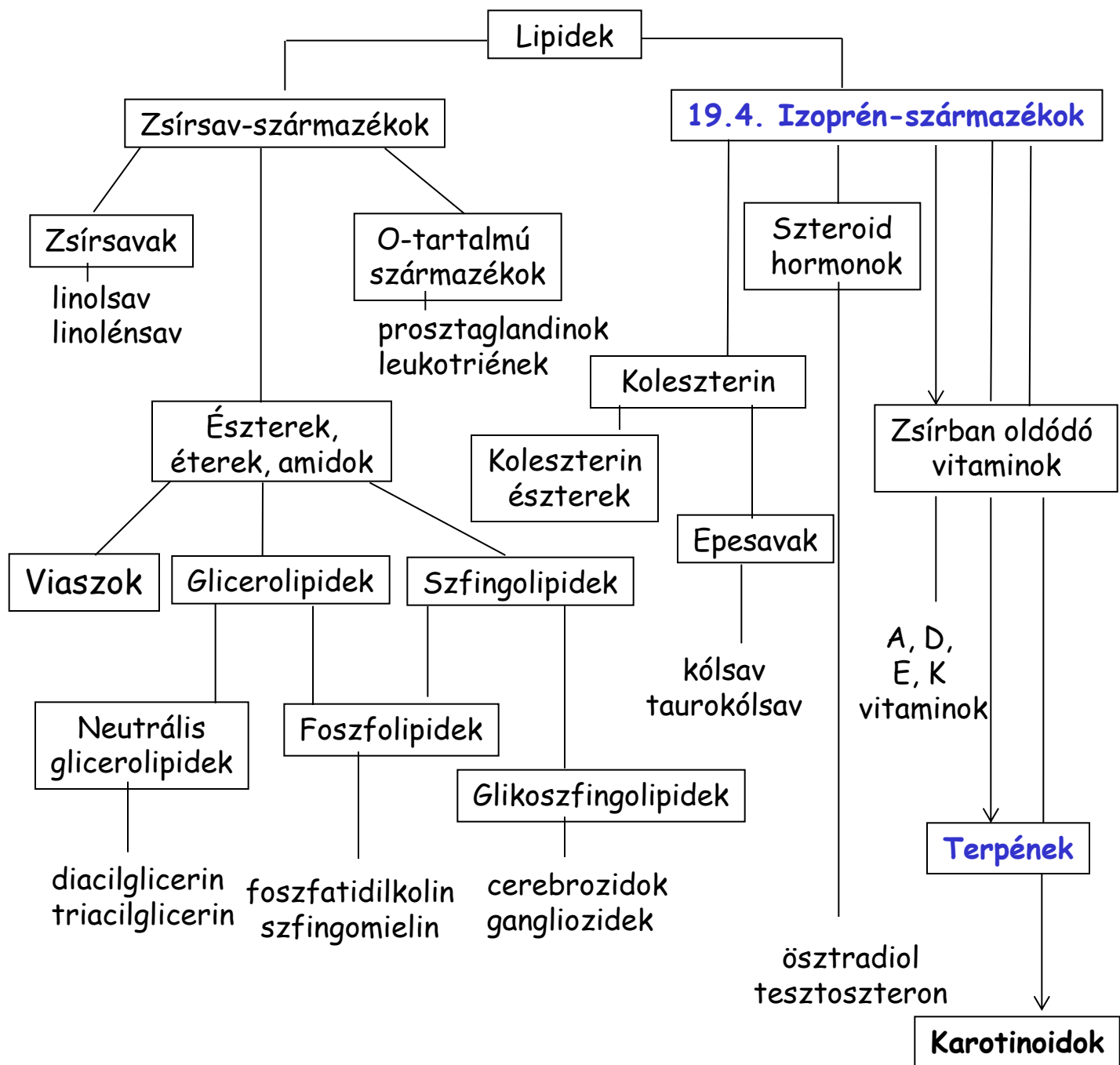
Buckminster, Fullerén

Soccerballen, Footballen



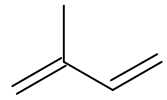
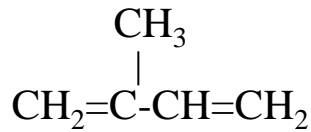
Sir Harold Walter Kroto
(Budapest, 2001)

Egyszerű lipidek



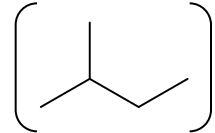
19. 4. Izoprénvázas vegyületek

1. Terpének



2. Karotinoidok

2-metil-1,3-butadién
[izoprén]

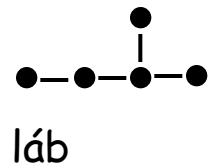
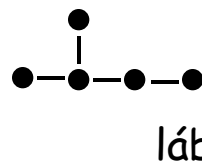
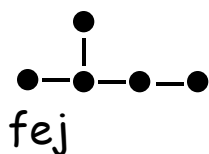
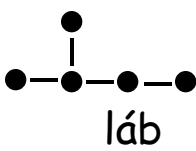


1. Terpének

- növényi illóolajok, gyanták, balzsamok
- aciklusos vagy ciklusos

Név	Képlet	Izoprén egység	
monoterpén	$\text{C}_{10}\text{H}_{16}$	2	} illó
szeszkviterpén	$\text{C}_{15}\text{H}_{24}$	3	
diterpén	$\text{C}_{20}\text{H}_{32}$	4	
triterpén	$\text{C}_{30}\text{H}_{48}$	6	
tetraterpén	$\text{C}_{40}\text{H}_{64}$	8	
politerpén	$(\text{C}_5\text{H}_8)_n$	$n > 8$	kaucsuk

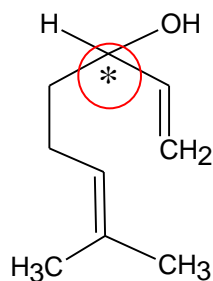
Kapcsolódási mód (Ruzička, 1921)



Izoprén-szabály: fej-láb

Néhány illóolaj és komponens

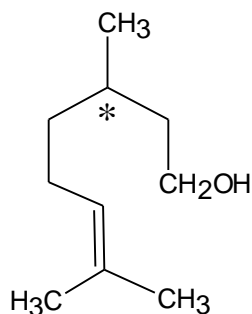
Babérfa	mircén, ocimén
Narancsvirág (Neroliolaj)	nerol
Gyöngyvirág	linaldol
Rózsaolaj	citronellol
Ibolyaolaj	a-jonon b-jonon
Borsmenta	mentol (50-60%) menton (38%)
Kömény	carvon fenchán
Eucalyptus	1,8-cineol
Tűlevelűek	a-pinén
Kámforfa	d(+)-kámfor
Levendula	d(+)-borneol



fp: 198 °C

$[\alpha]_D = \pm 20^\circ$

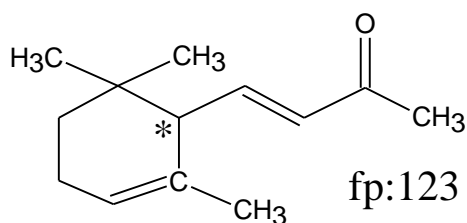
linaldol



fp: 114 °C

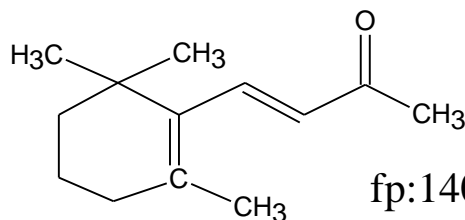
$[\alpha]_D = \pm 4^\circ$

citronellol



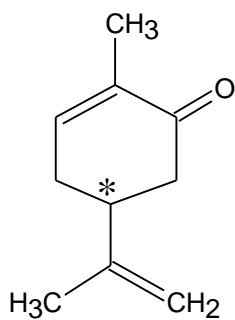
fp: 123 °C

α-jonon



fp: 140 °C

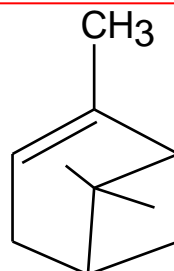
β-jonon



fp: 230 °C

$[\alpha]_D = \pm 62^\circ$

carvon

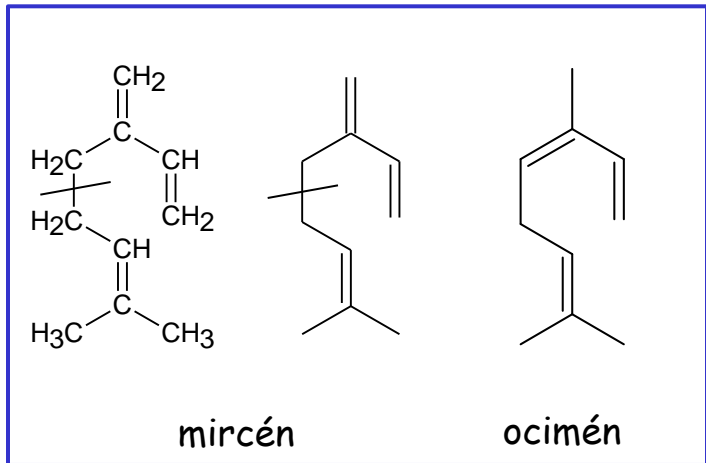


α-pinén

fp: 156 °C

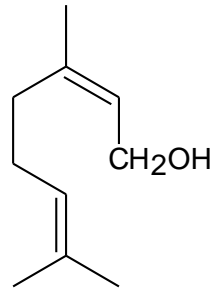
$[\alpha]_D = \pm 49^\circ$

1.1. Aciklusos monoterpének és származékaik



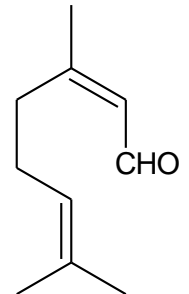
(babérfa illóolaj)

nerol (cisz)
narancsvirág



geraniol
(transz)

neral (cisz)

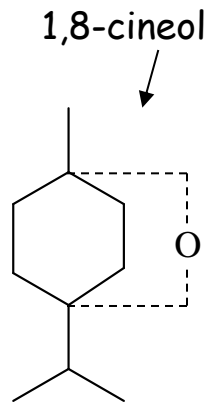
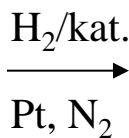
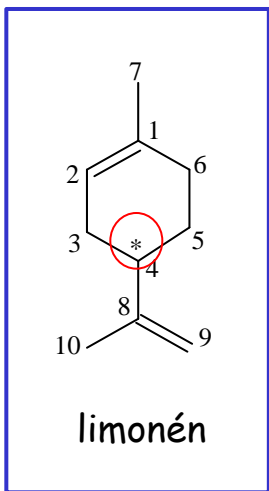


geranial
(transz)

citromfűolaj

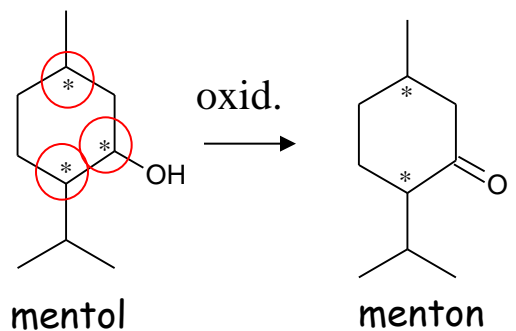
1.2. Monociklusos monoterpének, származékaik

Két izoprénrész ciklo-addíciójával vezethető le (csak kettőskötés)



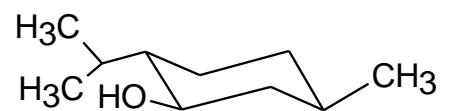
mentán

1-metil-4-izopropil-
-ciklohexán



borsmentaolaj 2 fő
komponense (95%)

Természetben:

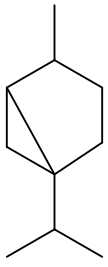


(-)-mentol

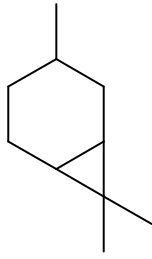
citromhéj, narancshéj,
kapor, zeller, kámfor,
bergamott [8 izomer]

1.3 Biciklusos monoterpének

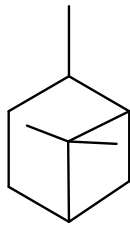
6 alapváz



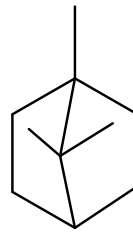
tuján



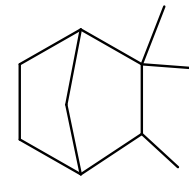
karán



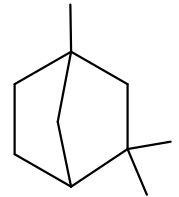
pinán



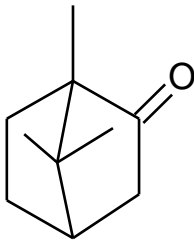
kamfán



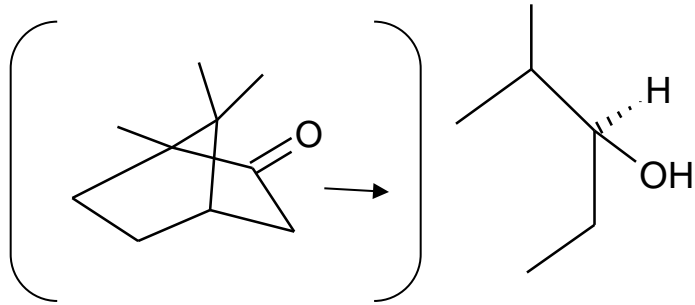
izokamfán



fenchán



kámfor

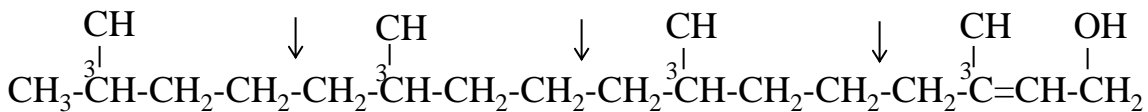


Izoborneol (levendula)

1.4. Diterpének és származékaik

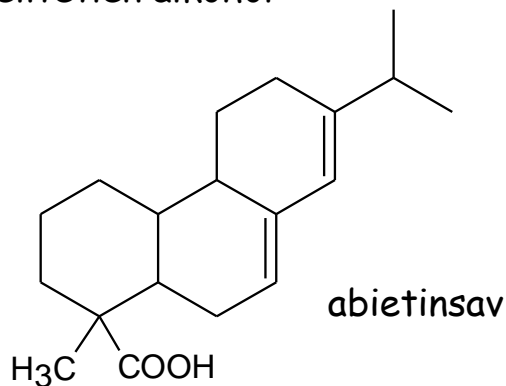
A. Aciklusos

Fitol, K vitamin, E vitamin, koenzim-Q, A vitamin



Fitol: 4 fej-láb izoprén, α - β telítetlen alkohol

B. Gyantasavak

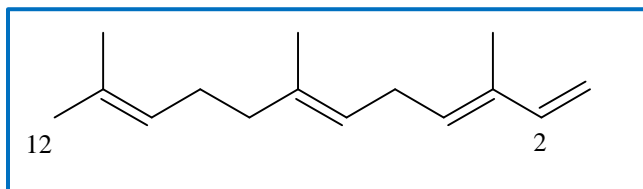


1.5. Szeszkviterpének

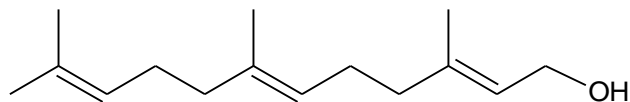
➤ 1000 tagú család

citotoxikus, gyulladásgátló, vírus- és gombaellenes, feromon

1. Aciklusos

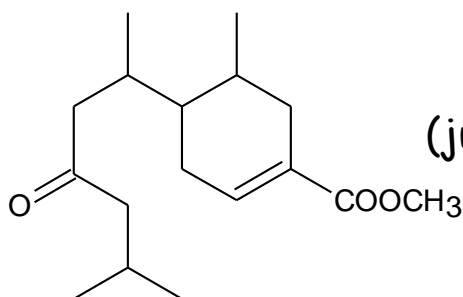


β -farnezen
(zöld tetű feromon)



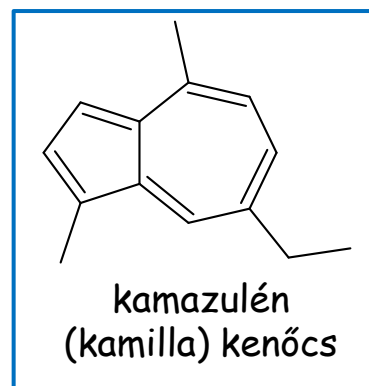
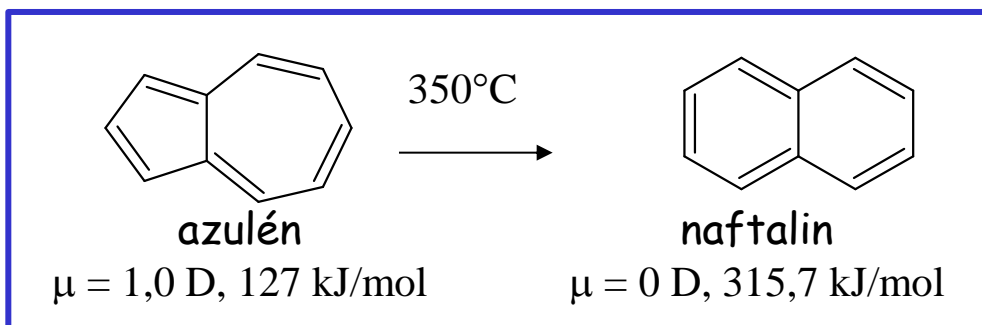
farnesol
hársfavirág, juvenil-hormon hatású

2. Ciklusos

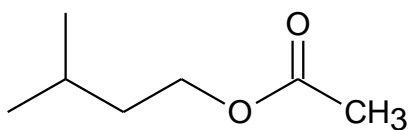


juvabion
(juvenil-hormon, fenyőgyanta)

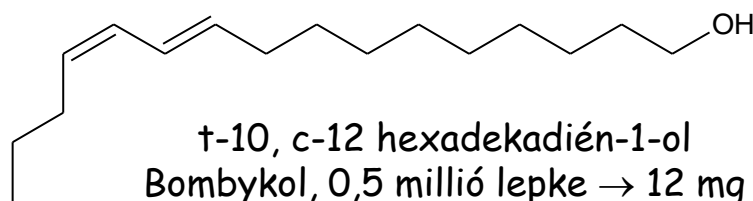
3. Azulének



4. Feromonok



izoamil-acetát (méhfullánk)



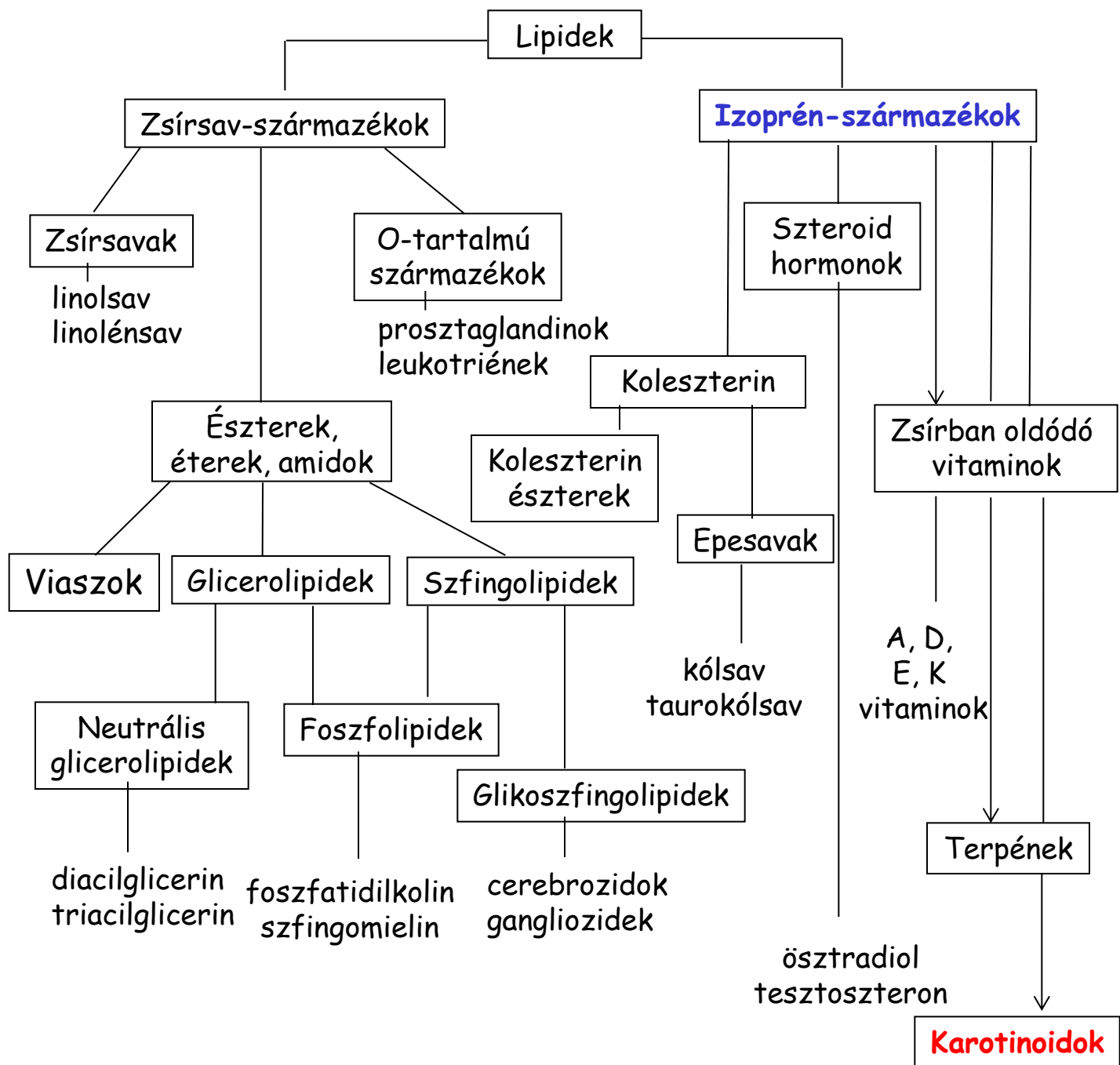
t-10, c-12 hexadekadién-1-ol
Bombykol, 0,5 millió lepke \rightarrow 12 mg

1.6. Triterpének

csukamájolajból izolálták (1916)

egyetlen aciklusos triterpén ismeretes: **szkvalén** [$\text{C}_{30}\text{H}_{50}$]

Egyszerű lipidek



2. Karotinoidok

(Zechmeister, Cholnoky)

Eredete: lipokrómok (zsírban oldódó természetes pigmentek)

sárgarépa pigmentje: (daucus carota) karotin (Wackenroder, 1831)

Szín → szerkezet → szerkezetfelderítés

a) kromatográfia

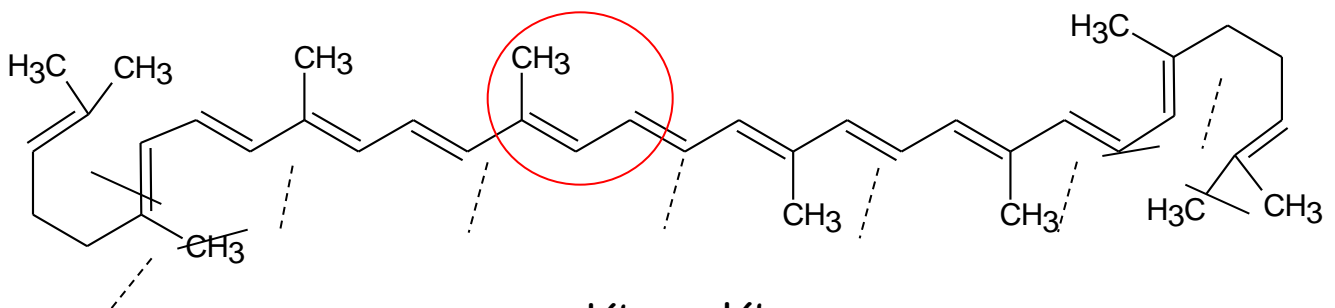
b) oxidatív lebontás

c) $\lambda = 400\text{-}510$ nm spektrum

2.1. Likopin: paradicsom (*Lycopersicum esculentum*)

piros pigmentje

$C_{40}H_{56}$ „all-transz” (72 létképes izomer)

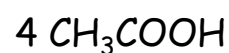


láb

láb

ozonidos
lebontás

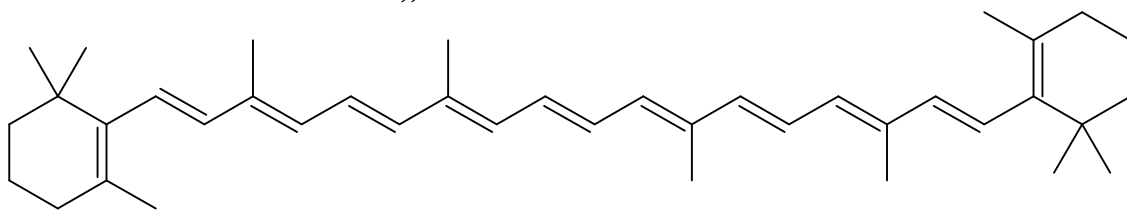
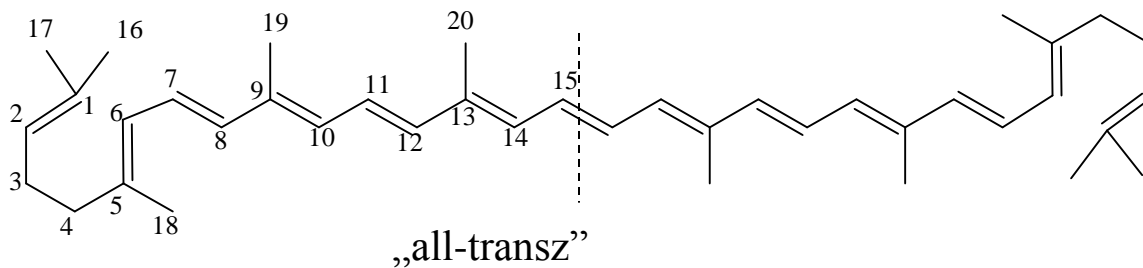
$KMnO_4$
oxidáció



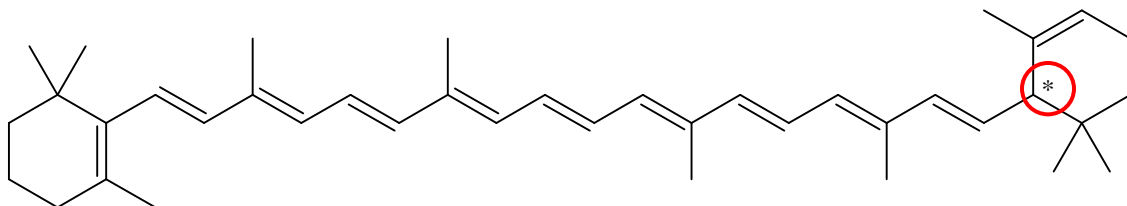
(levulinaldehid)

2.1. Karotin: sárgarépból izolált (keverék: $\beta > \alpha > \gamma$)

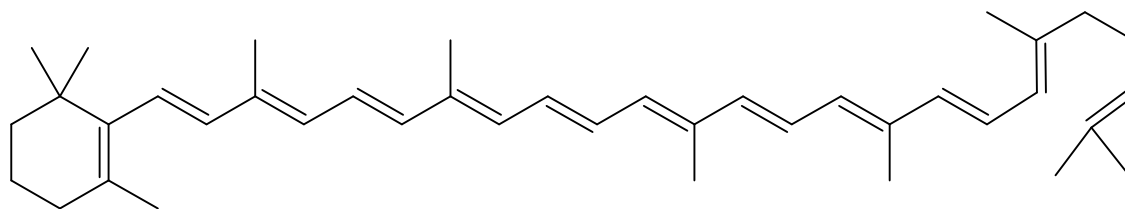
$C_{40}H_{56}$ (likopin izomer!) előfordulás: klorofillel együtt



β -karotin, op.: 183°C , $\lambda_{\text{max}} = 425, 450$ és 477 nm

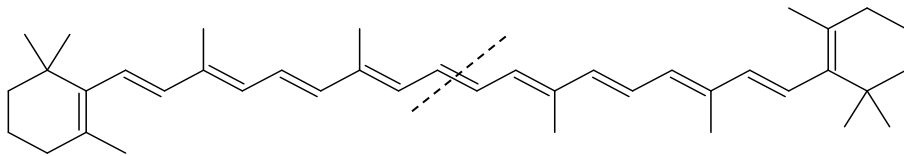


α -karotin, op.: 188°C , $\lambda_{\text{max}} = 420, 445$ és 475 nm, $[\alpha]_{589} = +640^{\circ}$



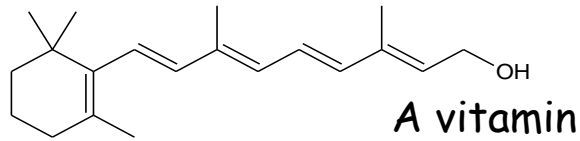
γ -karotin, op.: 178°C , $\lambda_{\text{max}} = 431, 462$ és 494 nm

A-vitamin



provitamin:
 β -karotin

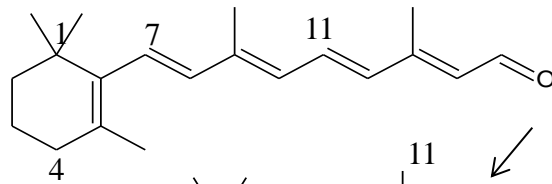
Kuhn, 1931
halak májából
növekedési
faktor,
Farkasvakság
0,5-1 mg/nap



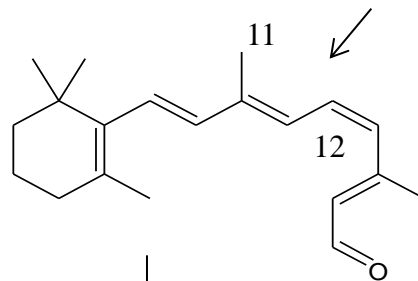
A vitamin

világos sárga olaj
fp.: 136°C (vákuum)
A₁

A₂ = dehidro



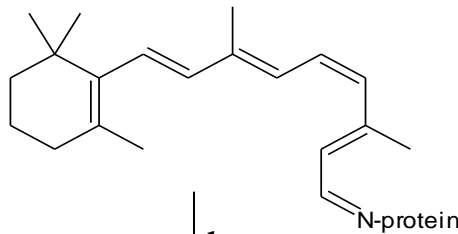
„all-transz” retinal



11-cisz-retinal

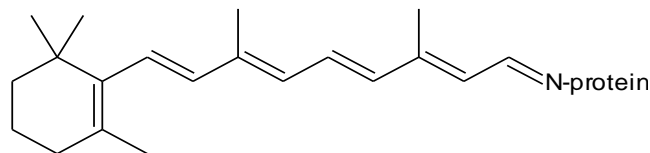
+ H₂N-protein

opszin

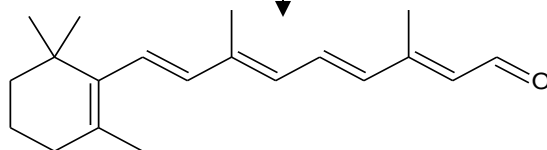


rodopszin

↓
h ν



↓
H₂O



+ H₂N-protein

1 nemzetközi egység (i.u.)
= 0,6 μ g kristályos
 β -karotin aktivitásával