Dr. Dunkel Petra
egyetemi adjunktus
SE Gyógyszerésztudományi Kar

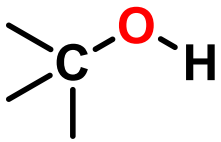
OXIGÉNTARTALMÚ SZERVES VEGYÜLETEK

sokszínű kémia
Egy tudomány – ezer lehetőség

OXIGÉNTARTALMÚ FUNKCIÓS CSOPORTOK

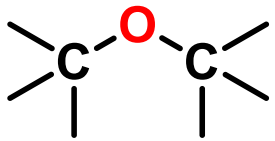
HIDROXIVEGYÜLETEK

ALKOHOLOK

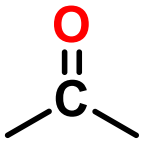


FENOLOK

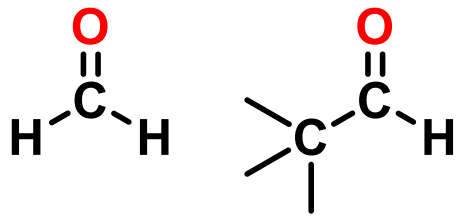
ÉTEREK



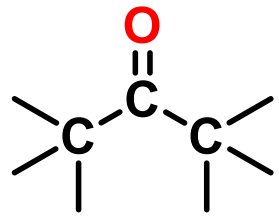
OXOVEGYÜLETEK



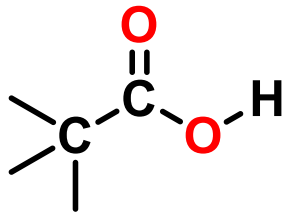
ALDEHIDEK



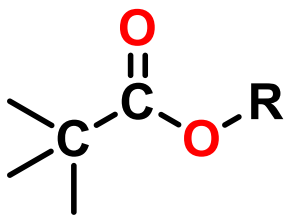
KETONOK



KARBONSAVAK



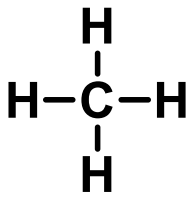
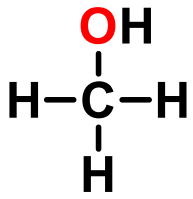
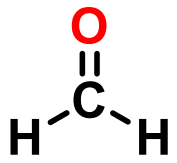
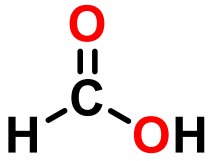
ÉSZTEREK

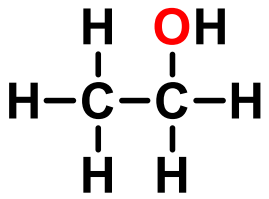
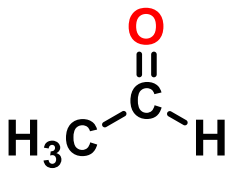
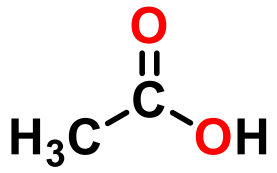


sokszínű kémia

OXIGÉNTARTALMÚ FUNKCIÓS CSOPORTOK

Oxidációs számok

metán	metanol	formaldehid	hangyasav	szén-dioxid
				
-4	-2	0	+2	+4

etanol	acetaldehid	ecetsav
		
-3 -1	-3 +1	-3 +3

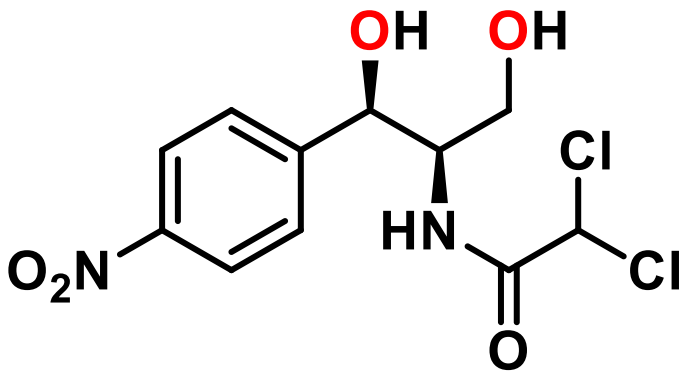
sokszínű kémia

ALKOHOLOK

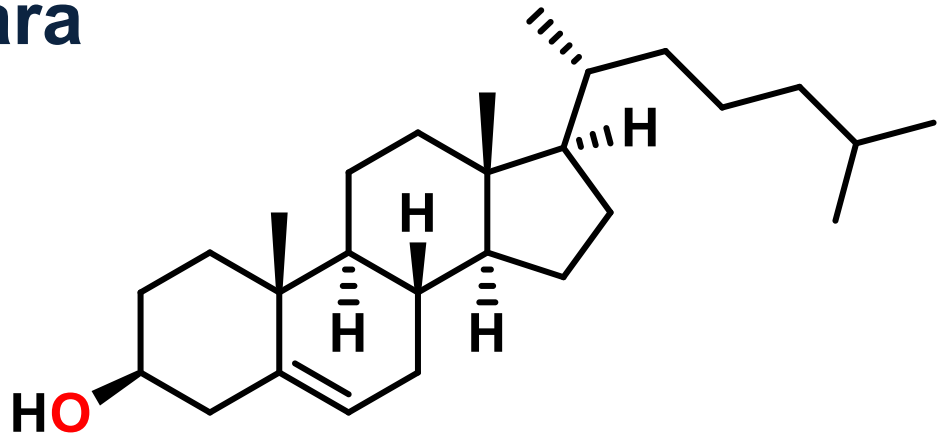
1

ALKOHOLOK

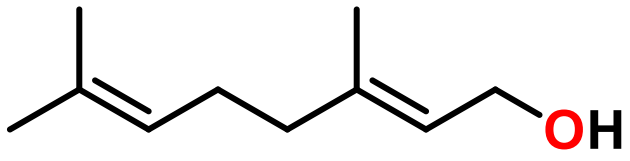
Példák alkoholok előfordulására



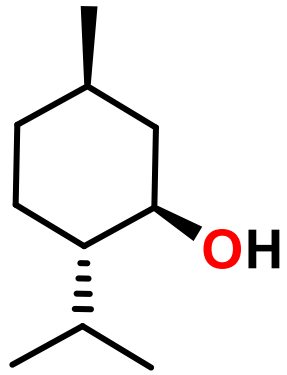
klóramfenikol
antibiotikum



koleszterin



geraniol
illata miatt pl. parfümökben használják



(-)-mentol

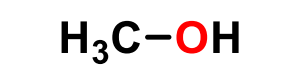
sokszínű kémia

ALKOHOLOK

NEVEZÉKTAN: megfelelő szénhidrogén neve + **-ol** végződés

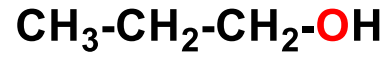
alkan**ol**

alkilcsoport neve + **alkohol**

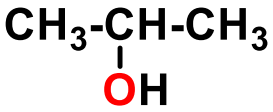


metanol
metil-alkohol

etanol
etil-alkohol



propán-1-ol
propil-alkohol



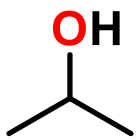
propán-2-ol
izopropil-alkohol

1) Főlánc kiválasztása
2) Szubsztituensek azonosítása
3) Számozás
4) Szubsztituensek felsorolása (ABC)

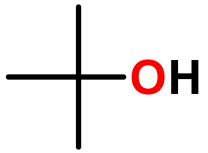
sokszínű kémia

ALKOHOLOK

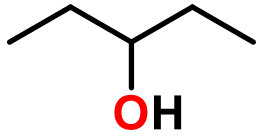
Példák alkoholok elnevezésére:



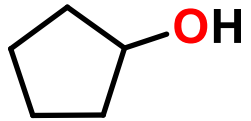
propán-2-ol
izopropil-alkohol



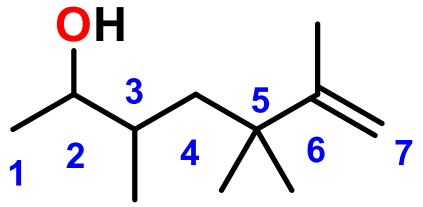
2-metilpropán-2-ol
tercier-butil-alkohol
terc-butanol



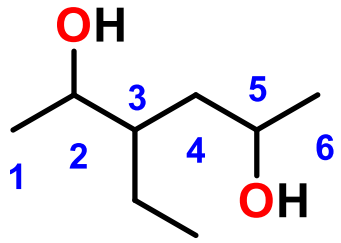
pentán-3-ol



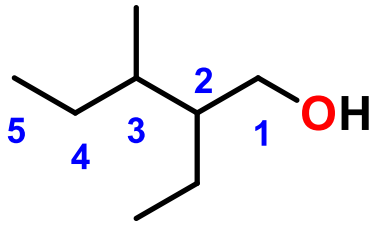
ciklopentanol



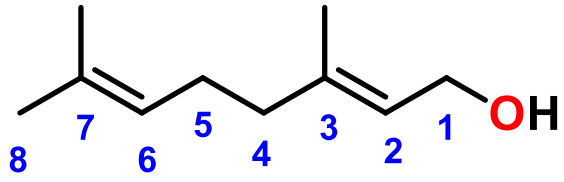
3,5,5,6-tetrametilhept-6-én-2-ol



3-etilhexán-2,5-diol



2-etil-3-metilpentán-1-ol



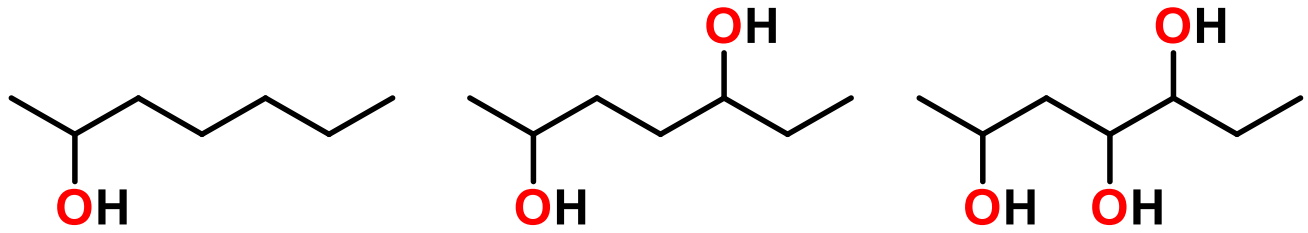
(2*E*)-3,7-dimetilokta-2,6-dién-1-ol

sokszínű kémia

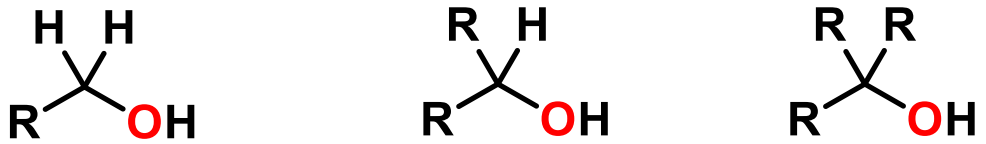
ALKOHOLOK

Csoportosítás:

- értékűség szerint: hidroxilcsoportok száma (egy-, két-, három, többértékű)



- rendűség szerint: hidroxilcsoportot hordozó szénatom (elsőrendű/primer, másodrendű/szekunder, harmadrendű/tercier)

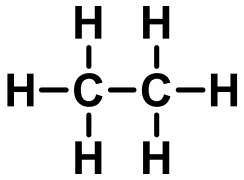


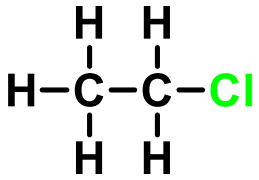
primer szekunder tercier

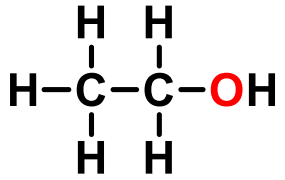
- szénhidrogéncsoport szerkezet szerint

sokszínű kémia

ALKOHOLOK – FIZIKAI TULAJDONSÁGOK

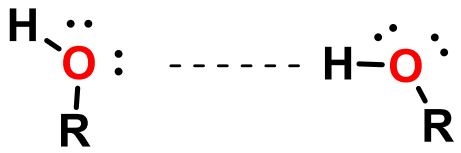




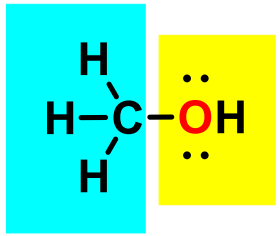


forráspont:	-89°C	12°C	78°C

hidrogénhíd kölcsönhatások

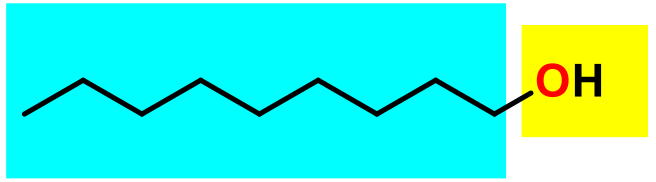


hidrofób rész



hidrofil rész

hidrofób rész



hidrofil rész

sokszínű kémia

ALKOHOLOK – KÉMIAI TULAJDONSÁGOK

- **Égés:** $C_2H_5\text{-}OH + 3\ O_2 = 2\ CO_2 + H_2O$

- **Sav-bázis tulajdonságok:**

$$\overset{+1}{C_2H_5\text{-}O}\ \overset{0}{H} + Na = \overset{+1}{C_2H_5\text{-}O}\ \overset{0}{Na} + \tfrac{1}{2}\ H_2\uparrow$$

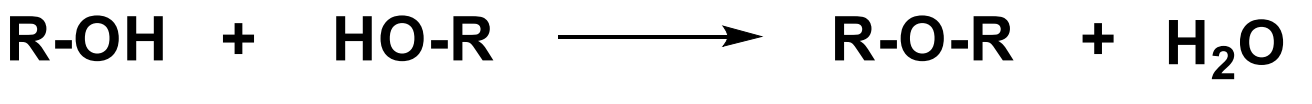
alkoxid ion

$$C_2H_5\text{-}O^{\ominus}\ Na^{\oplus} + H_2O \rightarrow C_2H_5\text{-}OH + Na^{\oplus} + {}^{\ominus}OH$$

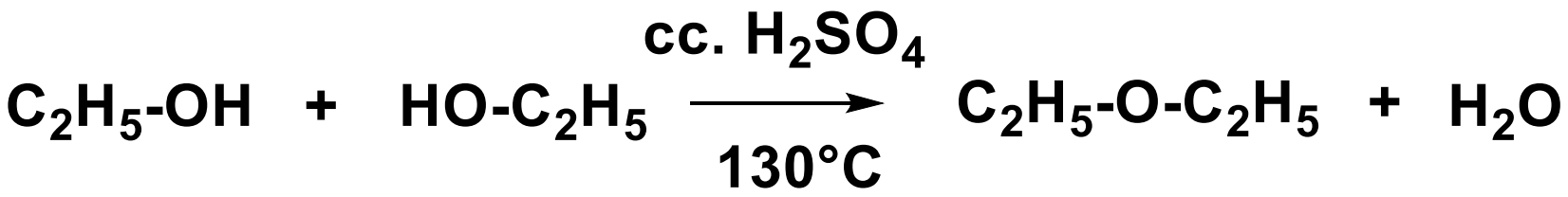
sokszínű kémia

ALKOHOLOK – KÉMIAI TULAJDONSÁGOK

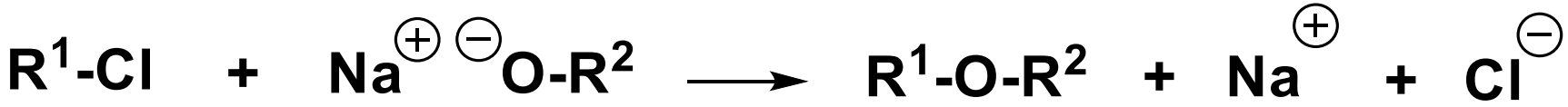
- **Éterek előállítása vízelvonással:**



vízelvonó szer



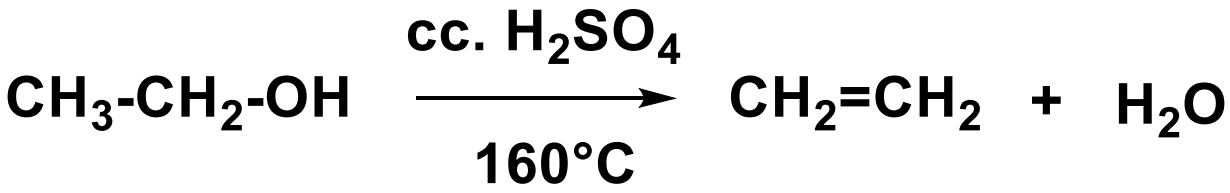
- **Nem szimmetrikus éterek előállítása:**

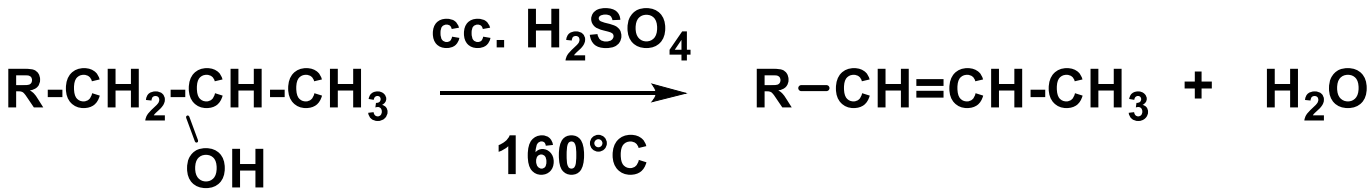


sokszínű kémia

ALKOHOLOK – KÉMIAI TULAJDONSÁGOK

- **Vízelimináció:**



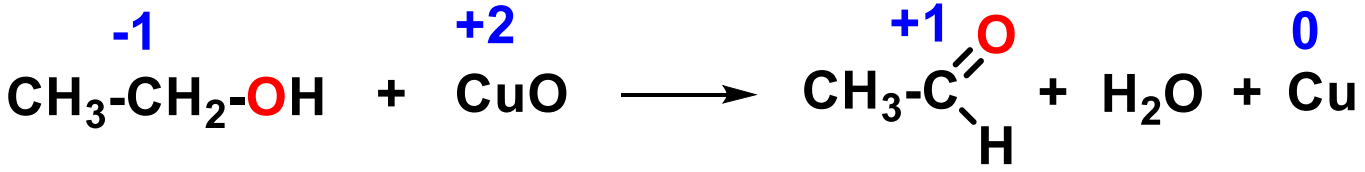


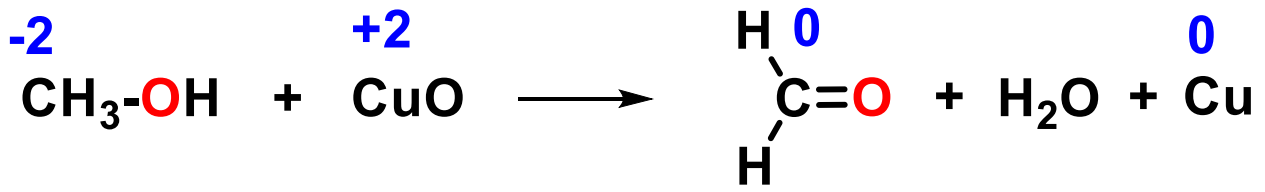
Zajcev-szabály

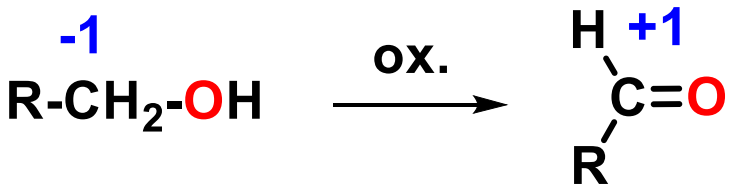
sokszínű kémia

ALKOHOLOK – KÉMIAI TULAJDONSÁGOK

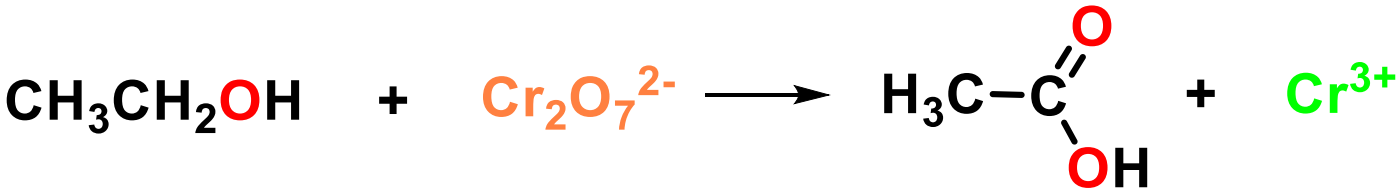
- **Dehidrogénezés:**







- **Alkoholszonda:**



sokszínű kémia

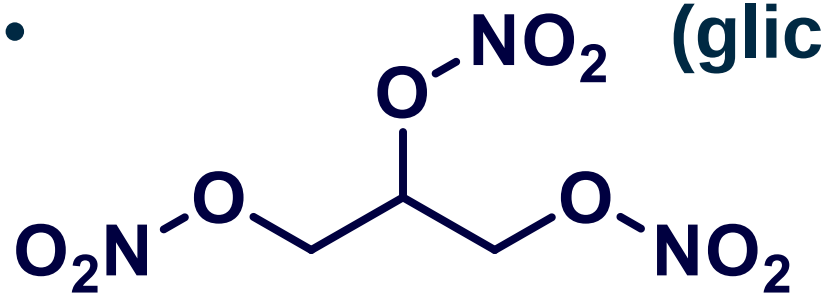
ALKOHOLOK – FONTOSABB PÉLDÁK

- CH_3OH (metanol, metil-alkohol, faszesz): $CO + H_2 \xrightarrow{\text{kat.}} CH_3OH$

  szintézisgáz

- CH_3CH_2OH (etanol, etil-alkohol, borszesz):

$$CH_2{=}CH_2 + H_2O \xrightarrow{\text{kat.}} CH_3\text{-}CH_2\text{-}OH$$

- $CH_2(OH)\text{-}CH_2(OH)$ (etilén-glikol, etán-1,2-diol)
- $CH_2(OH)\text{-}CH(OH)\text{-}CH_2(OH)$ (glicerin, propán-1,2,3-triol)
-  (glicerin-trinitrát, „nitroglicerin”)

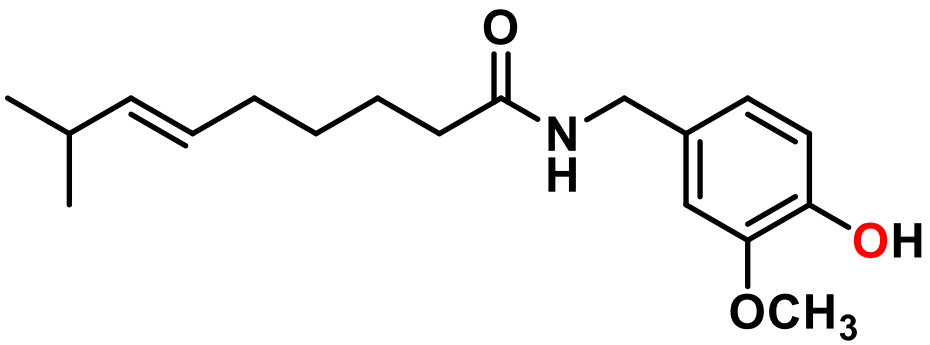
https://www.nobelprize.org/uploads/2018/06/alfred1.jpg

FENOLOK

2

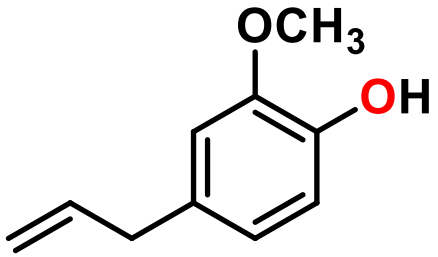
FENOLOK

Példák fenolok előfordulására



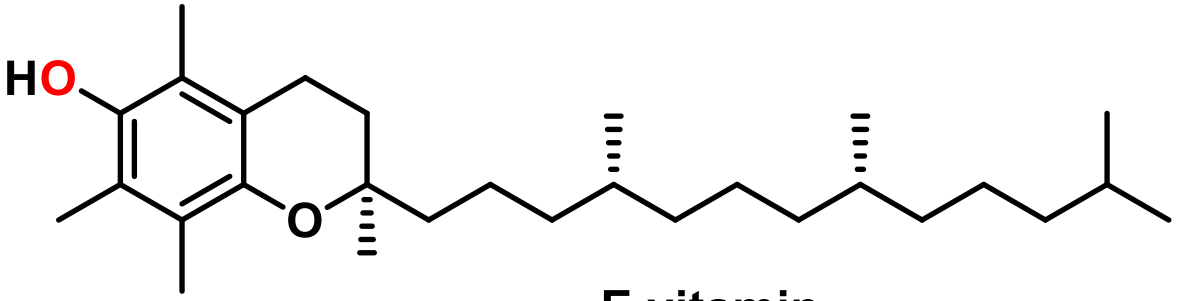
kapszaicin

paprikafélék csípős ízéért felel

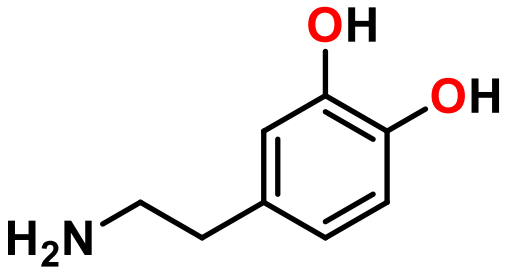


eugenol

előfordulás egyes illóolajokban, pl. szegfűszeg



E vitamin

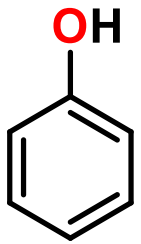


dopamin

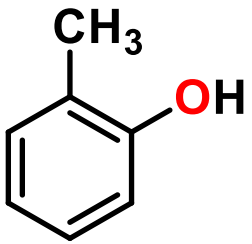
sokszínű kémia

FENOLOK

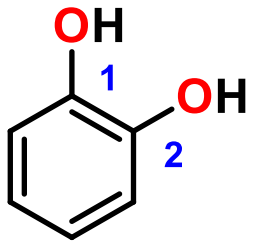
NEVEZÉKTAN: megfelelő aromás szénhidrogén neve + **-ol** végződés, vagy alapszénhidrogén hidroxi-származékaként elnevezés + triviális nevek



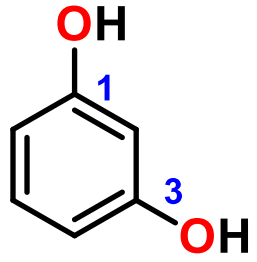
fenol



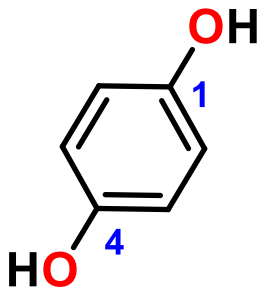
orto-krezol
2-metilfenol



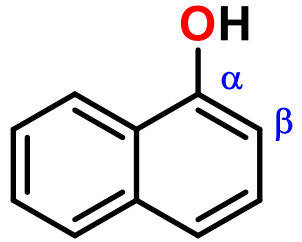
pirokatechin



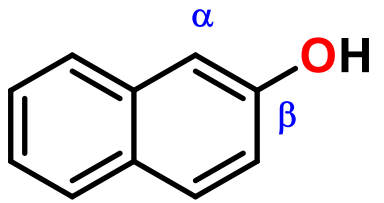
rezorcin



hidrokinon



1-naftol
α–naftol

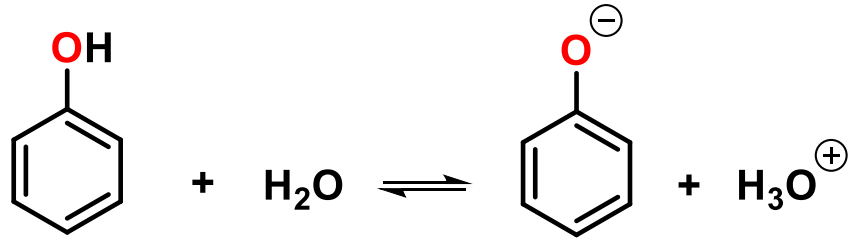


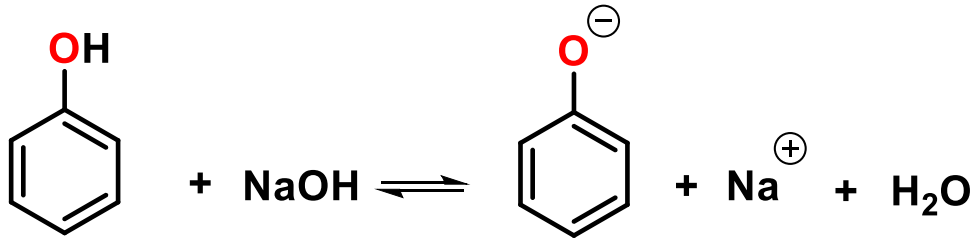
2-naftol
β-naftol

sokszínű kémia

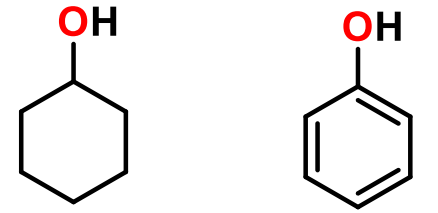
FENOLOK – KÉMIAI TULAJDONSÁGOK

- **Sav-bázis tulajdonságok:**



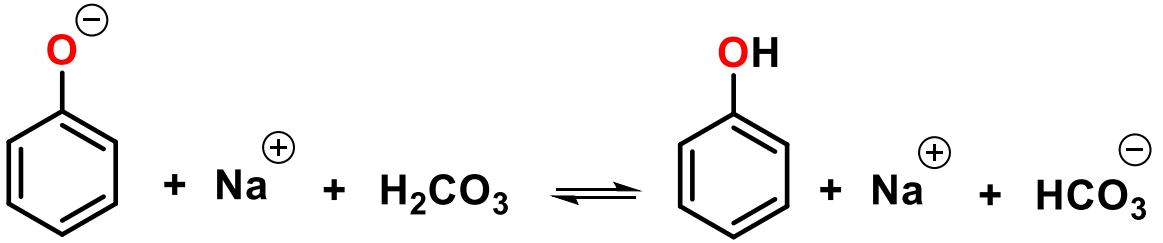


nátrium-fenolát
nátrium-fenoxid



pK_a=18

pK_a=10



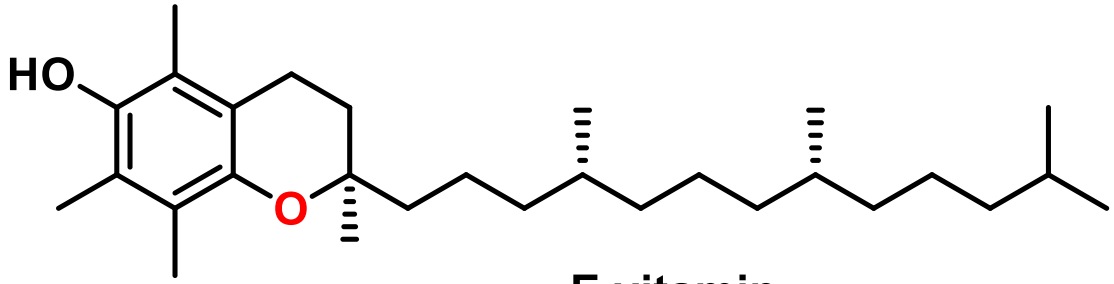
sokszínű kémia

ÉTEREK

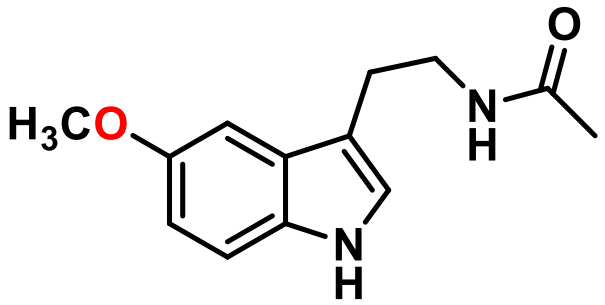
3

ÉTEREK

Példák éterek előfordulására

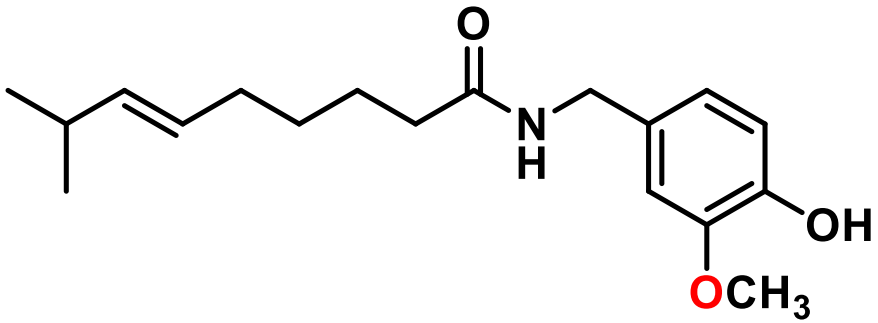


E vitamin



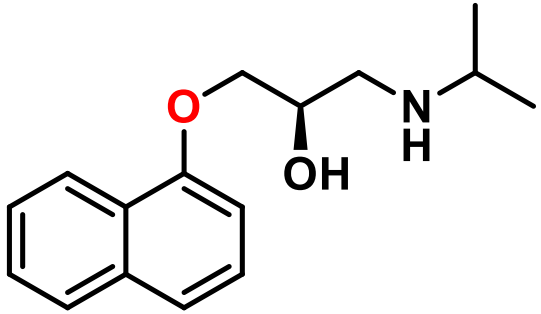
melatonin

alvási ciklust szabályzó hormon



kapszaicin

paprikafélék csípős ízéért felel



propranolol

magas vérnyomás kezelésében alkalmazott gyógyszer

sokszínű kémia

ÉTEREK

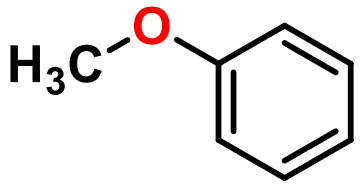
NEVEZÉKTAN: oxigénatomhoz kapcsolódó szénhidrogén-csoportok neve (ABC-sorrendben) + **-éter**

CH_3-O-CH_3

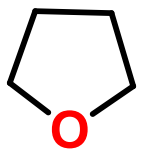
dimetil-éter

CH_3-CH_2-O-CH_2-CH_3

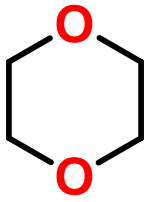
dietil-éter



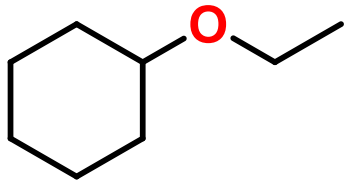
fenil-metil-éter



tetrahidrofurán



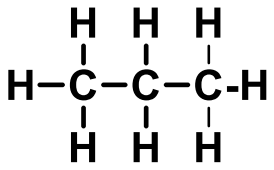
1,4-dioxán

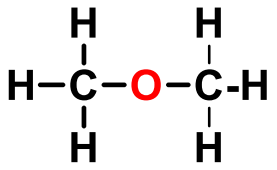


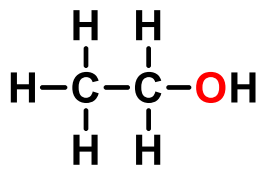
ciklohexil-etil-éter

sokszínű kémia

ÉTEREK – FIZIKAI TULAJDONSÁGOK

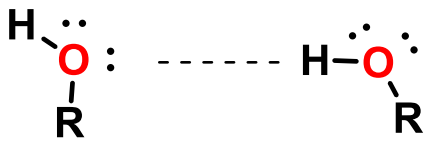




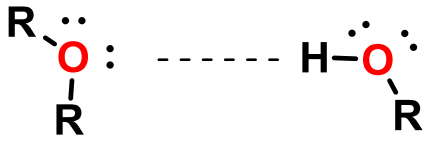


forráspont: -42°C -25°C 78°C

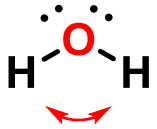
hidrogénhíd kölcsönhatások



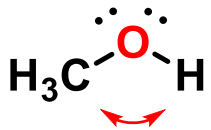
alkohol-alkohol



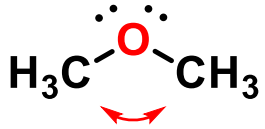
alkohol-éter



105°



109°



112°

sokszínű kémia

ÉTEREK – KÉMIAI TULAJDONSÁGOK

- **Égés:** $C_2H_5\text{-}O\text{-}C_2H_5 + 6\ O_2 = 4\ CO_2 + 5\ H_2O$

- **Éterek előállítása alkoholokból vízelvonással:**

$$R\text{-}OH + HO\text{-}R \longrightarrow R\text{-}O\text{-}R + H_2O$$

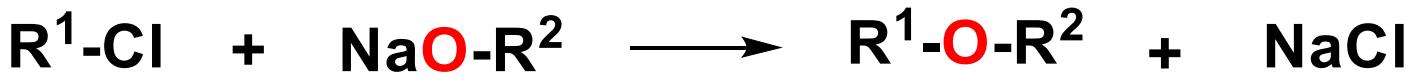
vízelvonó szer

$$C_2H_5\text{-}OH + HO\text{-}C_2H_5 \xrightarrow[130°C]{\text{cc. } H_2SO_4} C_2H_5\text{-}O\text{-}C_2H_5 + H_2O$$

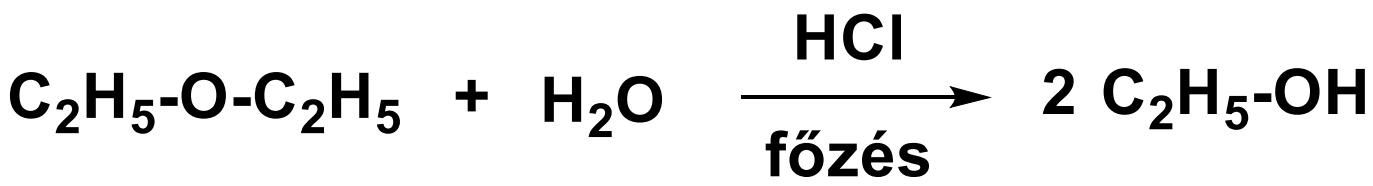
sokszínű kémia

ÉTEREK – KÉMIAI TULAJDONSÁGOK

- **Vegyes éterek előállítása:**



- **Éterek savas bontása:**



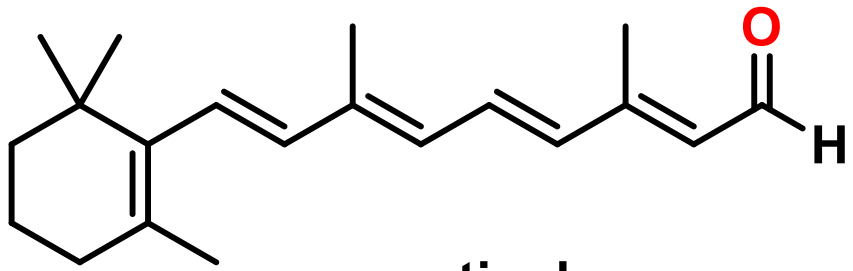
sokszínű kémia

4

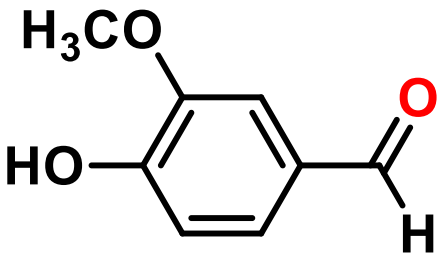
ALDEHIDEK

ALDEHIDEK

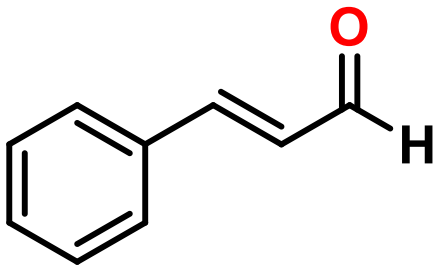
Példák aldehidek előfordulására



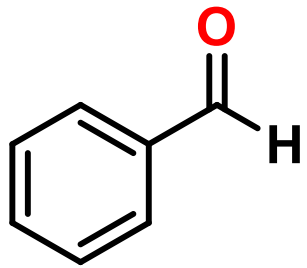
retinal
látás



vanillin



fahéjaldehid



benzaldehid
keserűmandula illat

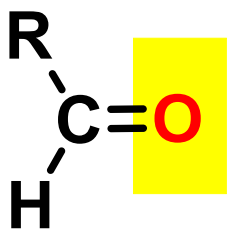
sokszínű kémia

ALDEHIDEK

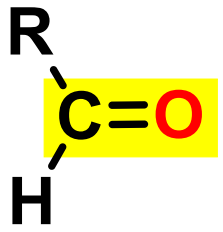
NEVEZÉKTAN: megfelelő szénhidrogén neve + **-al** végződés

alkan**al**

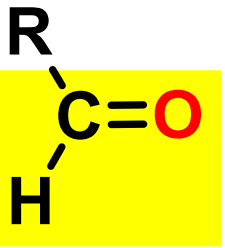
vagy megfelelő sav nevéből származtatás



oxocsoport



karbonilcsoport



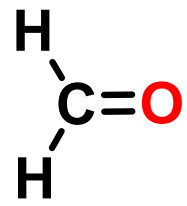
formilcsoport

1) Főlánc kiválasztása
2) Szubsztituensek azonosítása
3) Számozás
4) Szubsztituensek felsorolása (ABC)

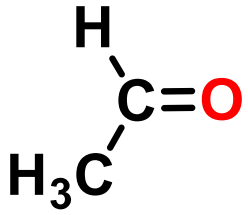
sokszínű kémia

ALDEHIDEK

Példák aldehidek elnevezésére:

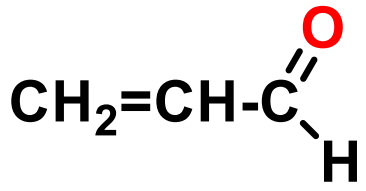


metanal
formaldehid

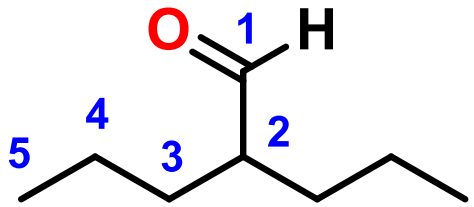


etanal
acetaldehid

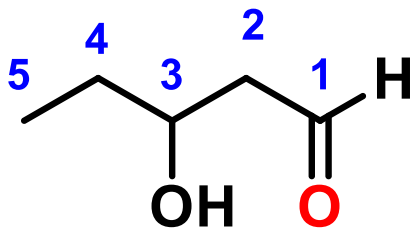
propándial



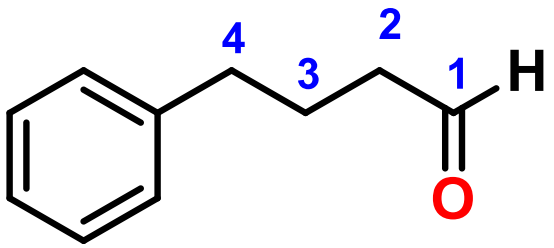
propénal
akrolein



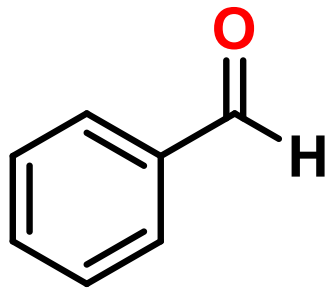
2-propilpentanal



3-hidroxipentanal



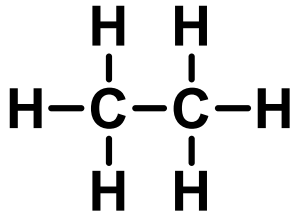
4-fenilbutanal

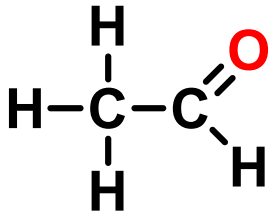


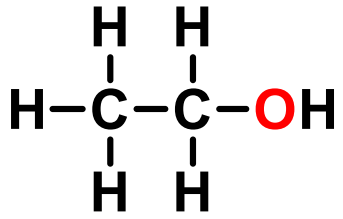
benzaldehid

sokszínű kémia

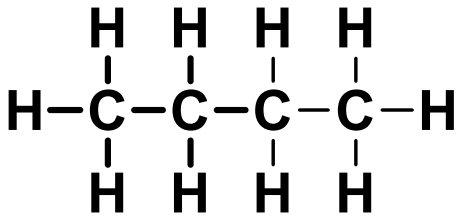
ALDEHIDEK – FIZIKAI TULAJDONSÁGOK

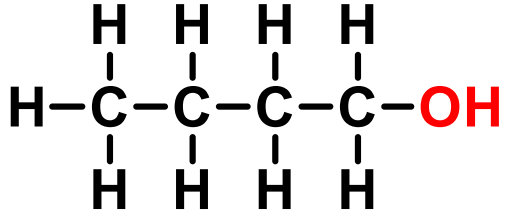






forráspont:	**-89°C**	**20°C**	**78°C**



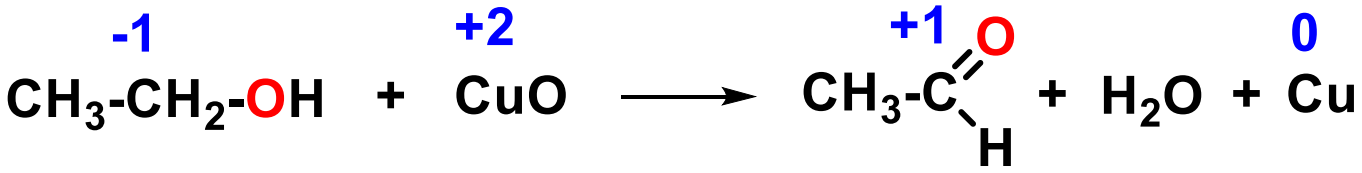


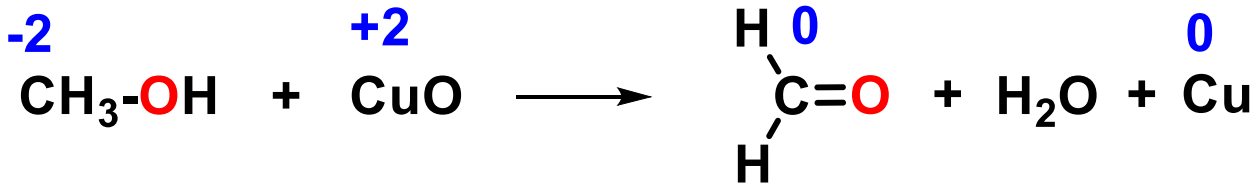
forráspont:	**0°C**	**75°C**	**118°C**

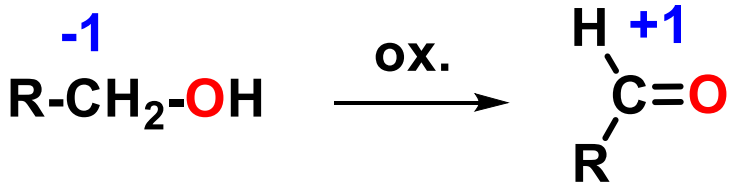
sokszínű kémia

ALDEHIDEK – KÉMIAI TULAJDONSÁGOK

- **Alkoholok oxidációja aldehiddé**





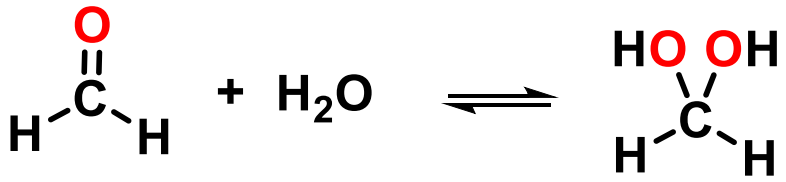


- **Égés: $CH_2O + O_2 = CO_2 + H_2O$**

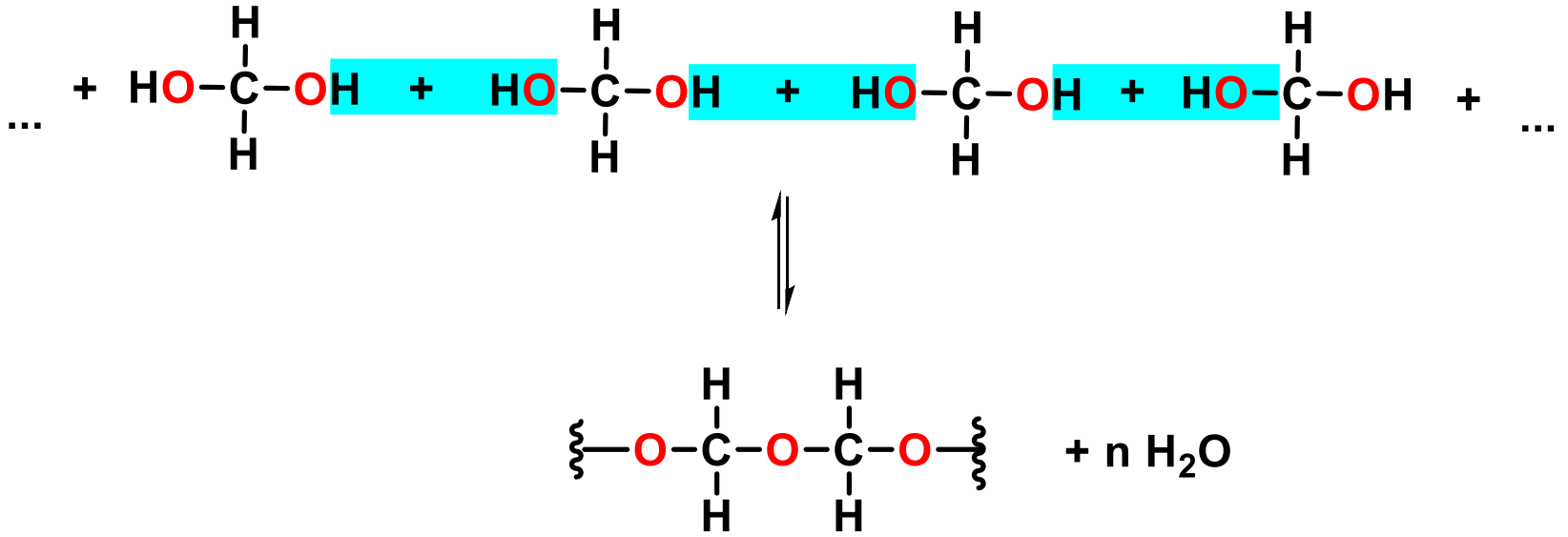
sokszínű kémia

ALDEHIDEK – KÉMIAI TULAJDONSÁGOK

- **Hidrát képződése vízzel:**

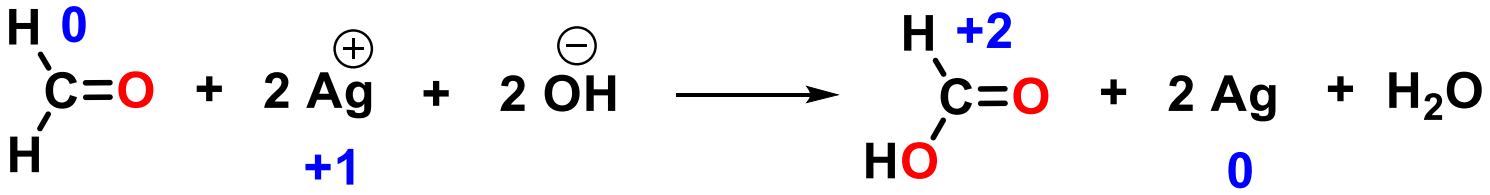


- **Paraformaldehid képződése**

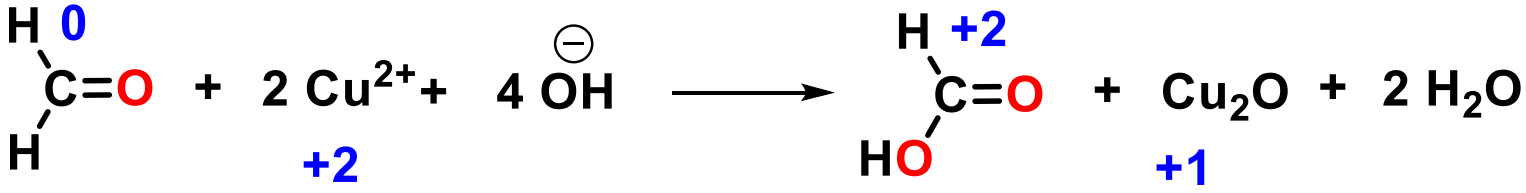


ALDEHIDEK – KÉMIAI TULAJDONSÁGO

- **Ezüsttükörpróba / Tollens-próba:**

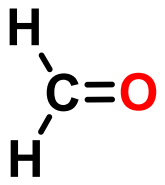


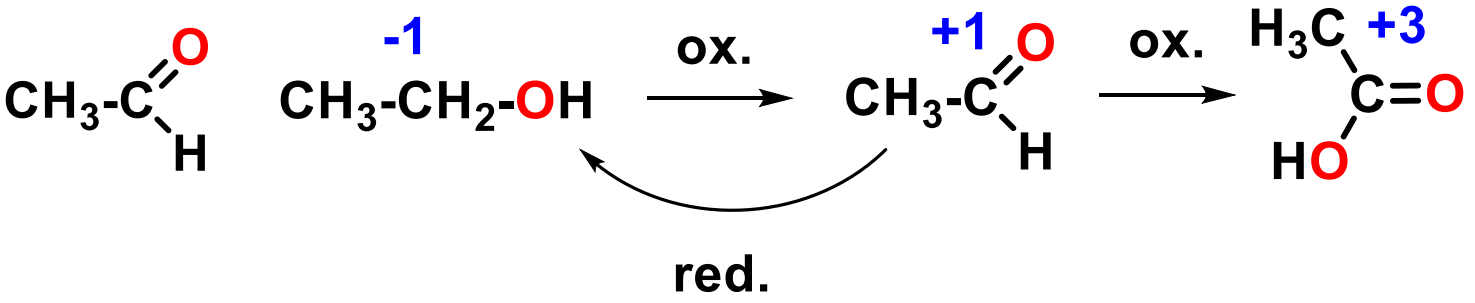
- **Fehling-reakció:** *Fehling I – $CuSO_4$, Fehling II – NaOH, kálium-nátrium-tartarát*

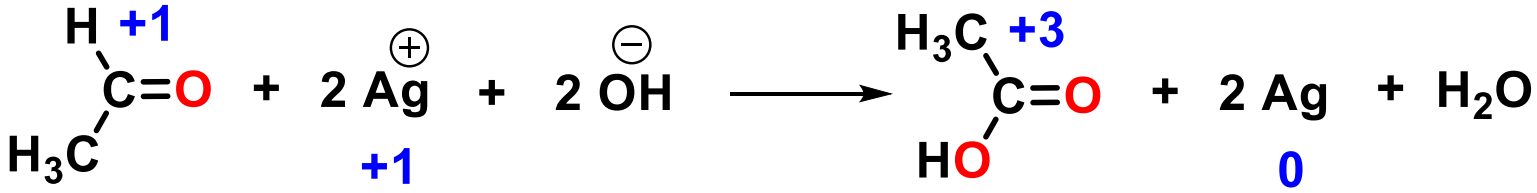


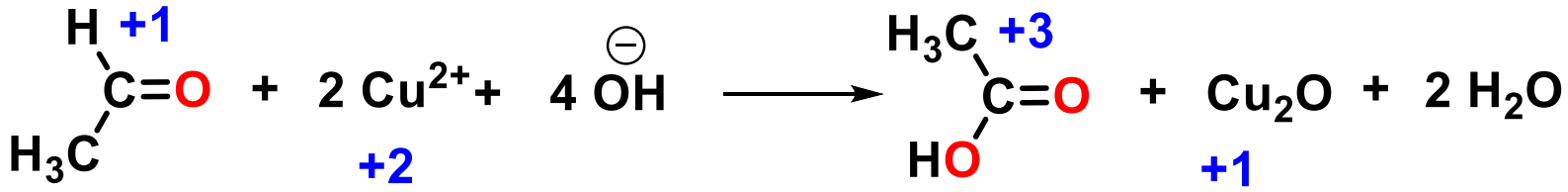
sokszínű kémia

ALDEHIDEK – FONTOSABB PÉLDÁK

- **Formaldehid (metanal):** 

- **Acetaldehid (etanal):** 





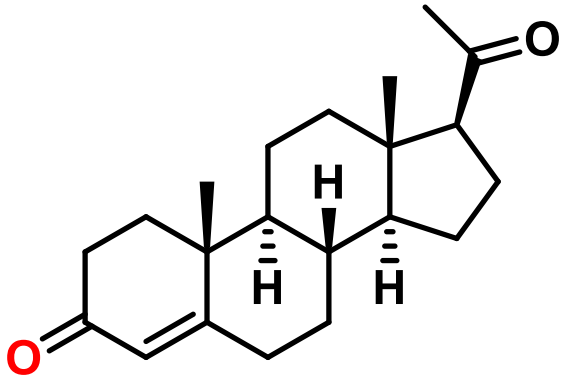
sokszínű kémia

KETONOK

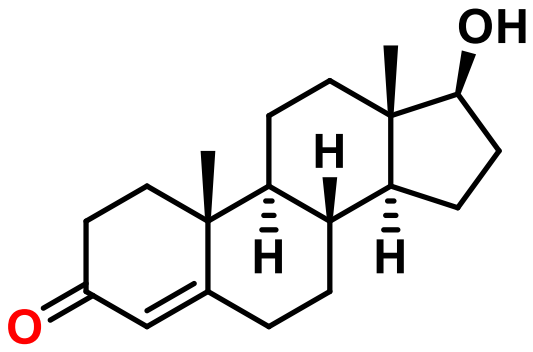
5

KETONOK

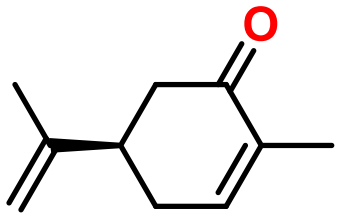
Példák ketonok előfordulására



progeszteron

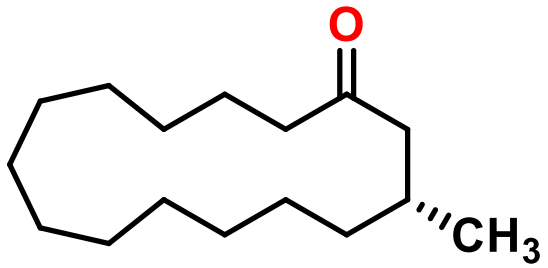


tesztoszteron



(*R*)-karvon

fodormenta illat



muszkon

pézsma

sokszínű kémia

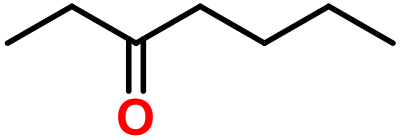
KETONOK

NEVEZÉKTAN: megfelelő szénhidrogén neve + **-on** végződés

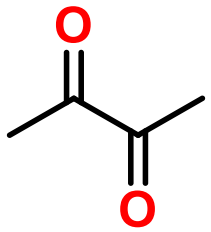
alkan**on**

+ oxocsoport helyzetének megadása számmal

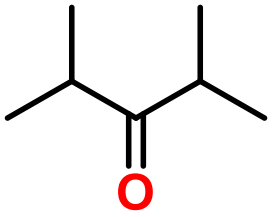
vagy szénhidrogéncsoportok felsorolása + keton



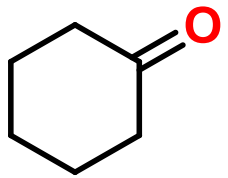
heptán-3-on
(butil-etil-keton)



bután-2,3-dion



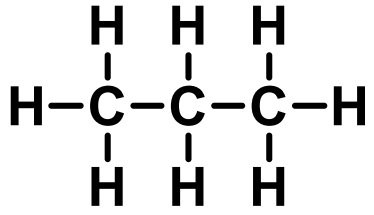
2,4-dimetilpentán-3-on

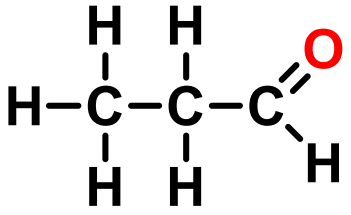


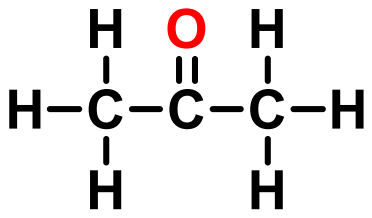
ciklohexanon

sokszínű kémia

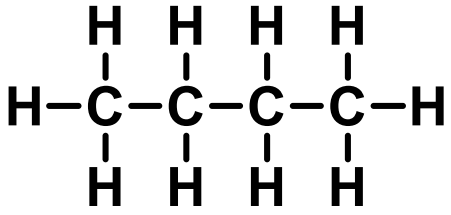
KETONOK – FIZIKAI TULAJDONSÁGOK

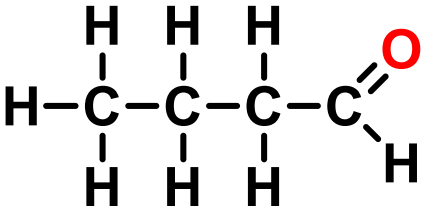


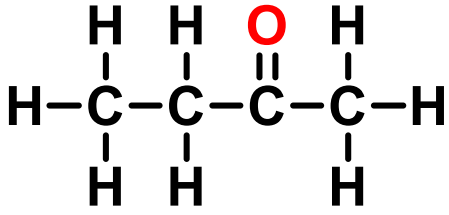




forráspont: **-42°C** **49°C** **56°C**





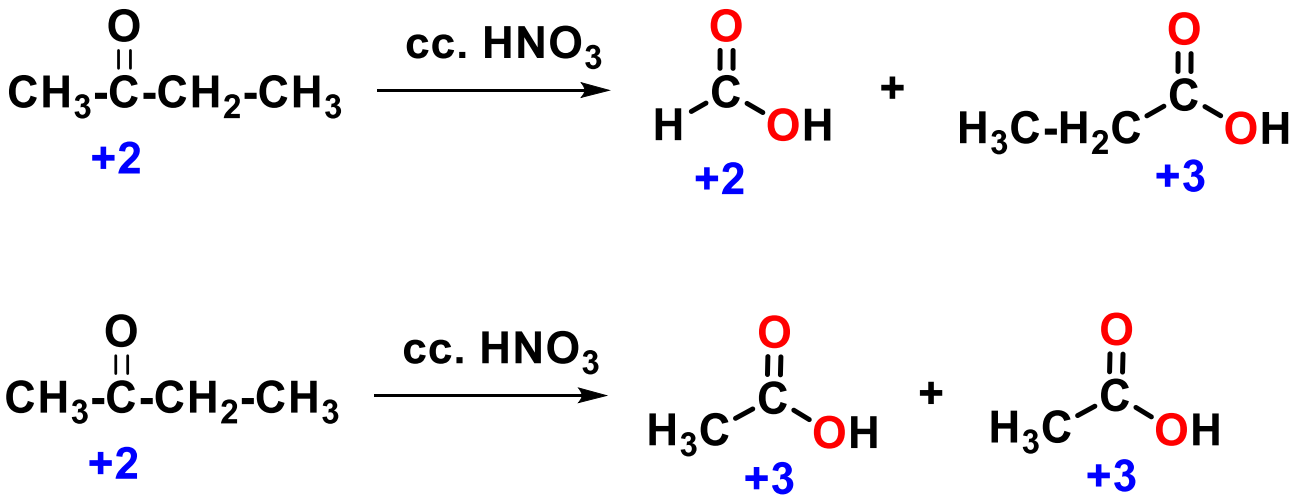


forráspont: **0°C** **75°C** **80°C**

sokszínű kémia

KETONOK – KÉMIAI TULAJDONSÁGOK

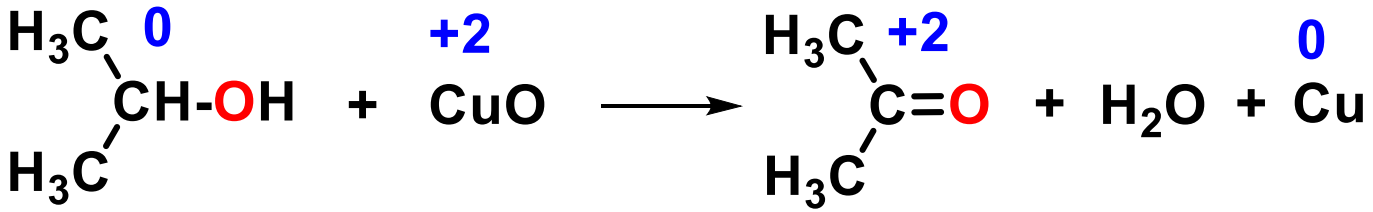
- **Aldehideknél kisebb reakciókészség, nem adják a Fehling- és az ezüsttükörpróbát**
- **Erélyes oxidáció lánchasadással:**

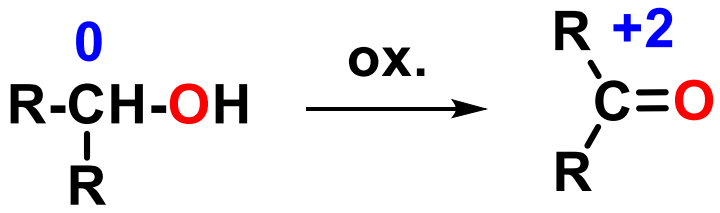


sokszínű kémia

KETONOK – KÉMIAI TULAJDONSÁGOK

- **Előállítás szekunder alkoholok oxidációjával:**





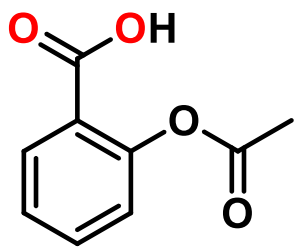
sokszínű kémia

6

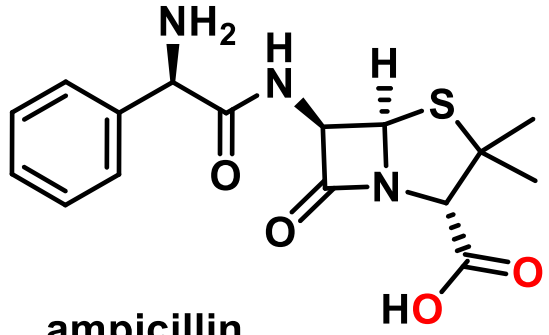
KARBONSAVAK ÉS SÓIK

KARBONSAVAK ÉS SÓIK

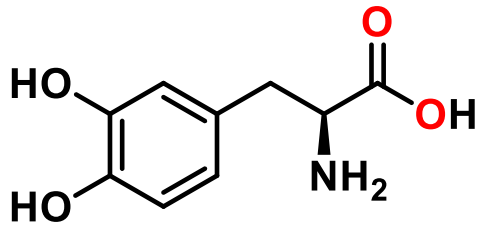
Példák karbonsavak előfordulására



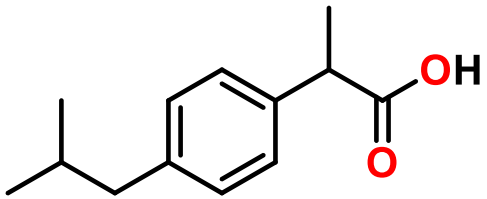
acetilszalicilsav



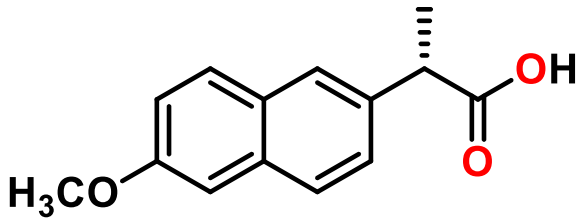
ampicillin
antibiotikum



levodopa
Parkinson-kór kezelésében alkalmazott szer



ibuprofén
nem-szteroid gyulladáscsökkentő

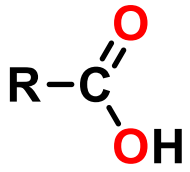


naproxén
nem-szteroid gyulladáscsökkentő

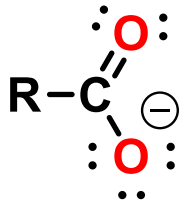
sokszínű kémia

KARBONSAVAK ÉS SÓIK

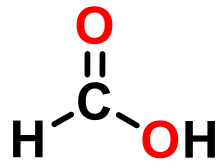
NEVEZÉKTAN: megfelelő szénhidrogén neve + **-sav** → főlánc tartalmazza karboxilcsoportot + szénatom-számba beleszámít vagy **-karbonsav** utótag (karboxilcsoport szénatomjai nem számítanak bele az alapszénhidrogén nevébe!) + triviális nevek



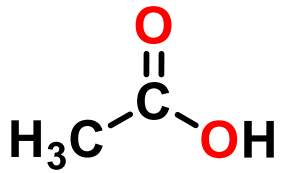
alkánsav



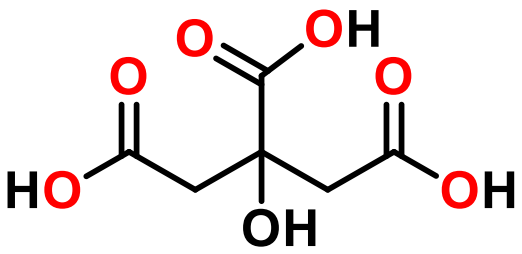
alkanoátion



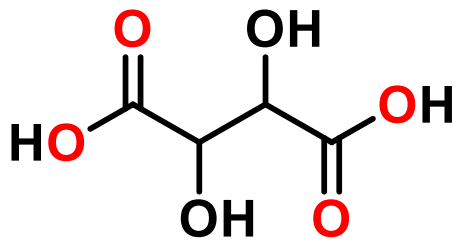
hangyasav



ecetsav



citromsav

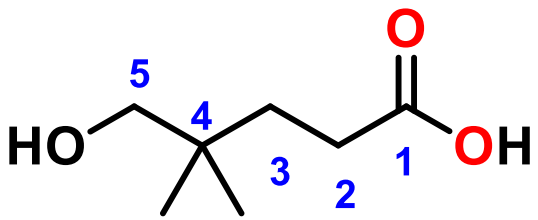


borkősav

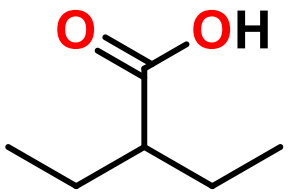
sokszínű kémia

KARBONSAVAK ÉS SÓIK

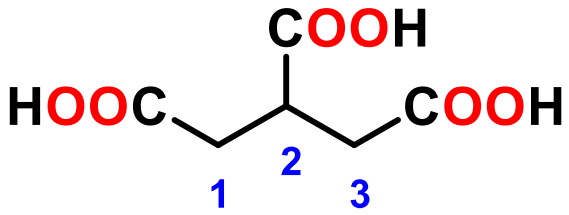
Példák karbonsavak elnevezésére:



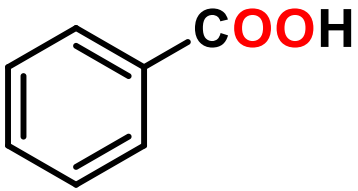
5-hidroxi-4,4-dimetilpentánsav



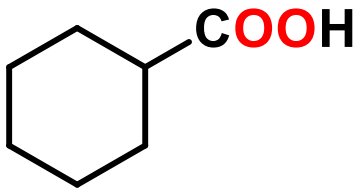
2-etilbutánsav



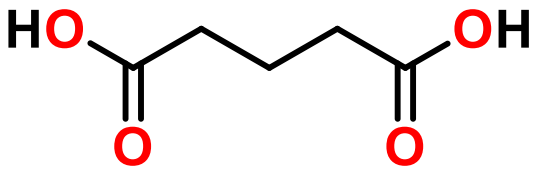
propán-1,2,3-trikarbonsav



benzoesav



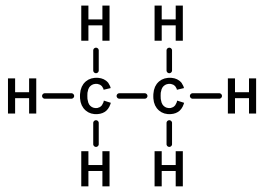
ciklohexánkarbonsav

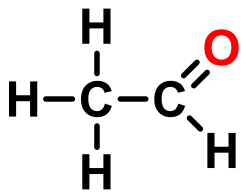


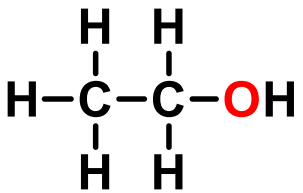
pentándisav

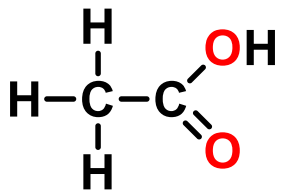
sokszínű kémia

KARBONSAVAK ÉS SÓIK – FIZIKAI TULAJDONSÁGOK



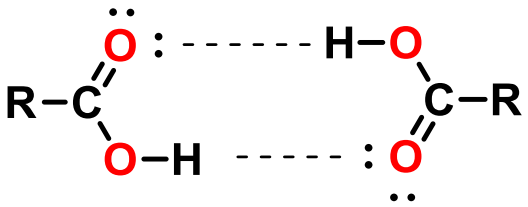






forráspont:	**-89°C**	**20°C**	**78°C**	**118°C**

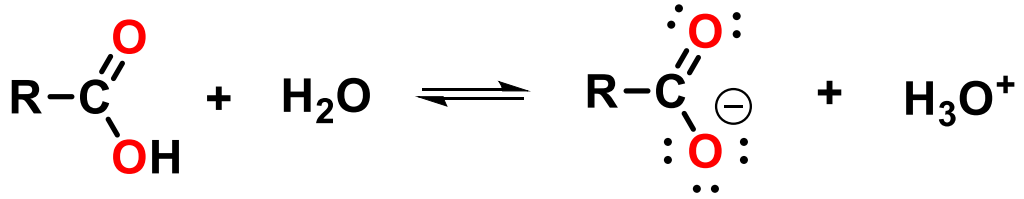
hidrogénhíd kölcsönhatások

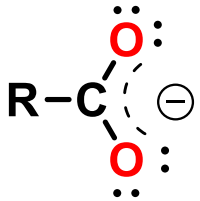


sokszínű kémia

KARBONSAVAK ÉS SÓIK – KÉMIAI TULAJDONSÁGOK

- **Aciditás:**





$$2\ HCOOH + Mg = 2\ HCOO^- + Mg^{2+} + H_2\uparrow$$

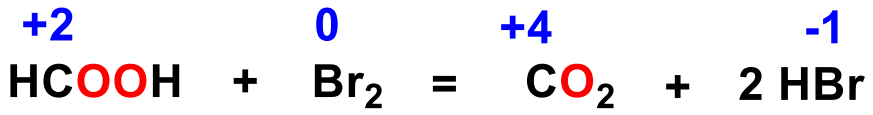
$$HCOOH + NaOH \rightleftharpoons \boxed{HCOO^- + Na^+} + H_2O$$

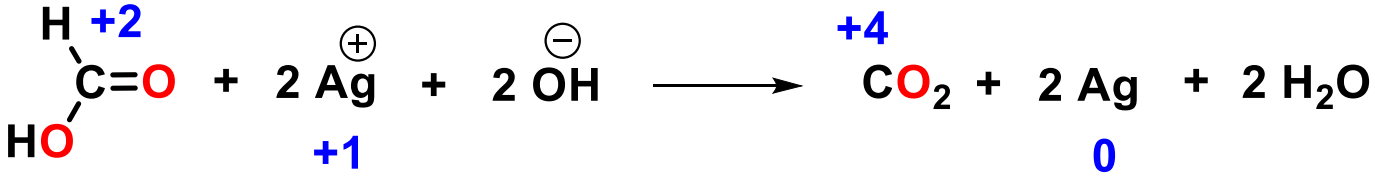
nátrium-metanoát
(nátrium-formiát)

sokszínű kémia

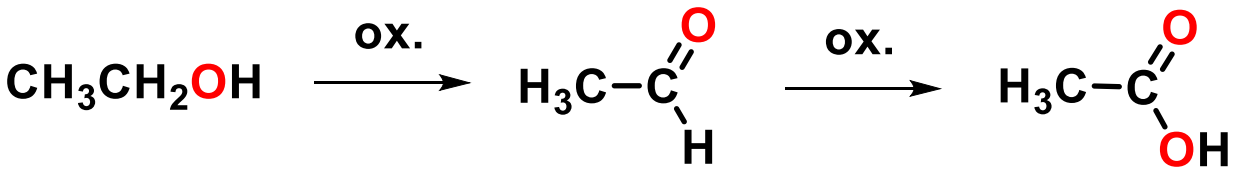
KARBONSAVAK ÉS SÓIK – KÉMIAI TULAJDONSÁGOK

- **Oxidáció:**





- **Anyagcsere-folyamatok:**

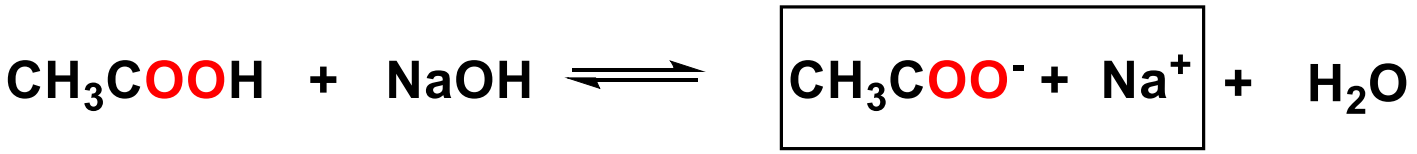


sokszínű kémia

KARBONSAVAK – FONTOSABB PÉLDÁK

- HCOOH (hangyasav, metánsav)
- CH_3COOH (ecetsav, etánsav)

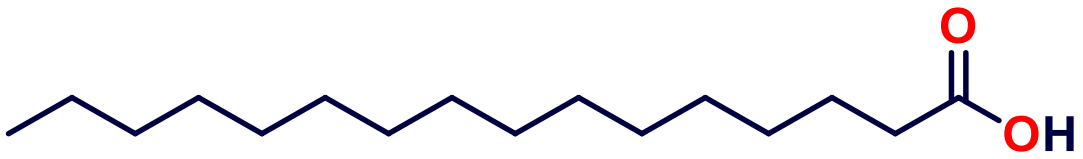
etanoátion
acetátion

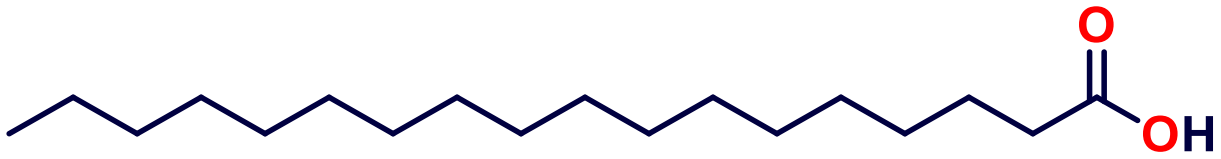


nátrium-etanoát
(nátrium-acetát)

sokszínű kémia

KARBONSAVAK – FONTOSABB PÉLDÁK

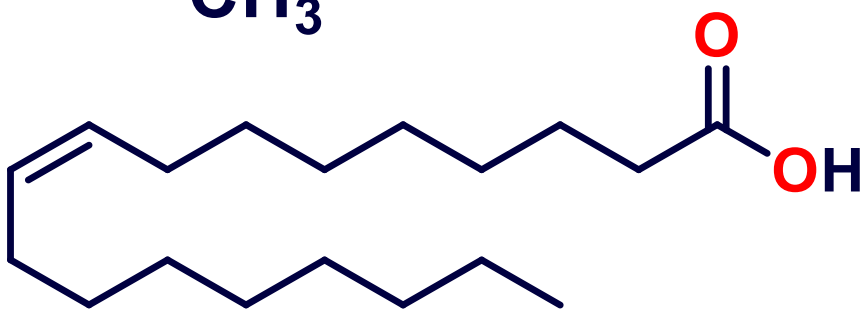
- CH_3CH_2COOH (propionsav, propánsav)
- $CH_3CH_2CH_2COOH$ (vajsav, butánsav)
- $CH_3CH_2CH_2CH_2COOH$ (valeriánsav, pentánsav)
- 

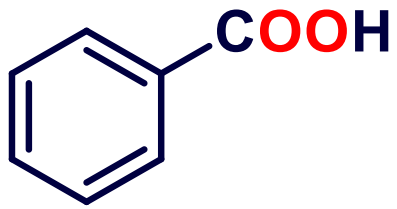
(palmitinsav, hexadekánsav)
- 

(sztearinsav, oktadekánsav)

sokszínű kémia

KARBONSAVAK – FONTOSABB PÉLDÁK

- CH_2=CH-COOH (akrilsav, prop-2-énsav)
- CH_2=C(-CH_3)-COOH (metakrilsav, 2-metilprop-2-énsav)
- 

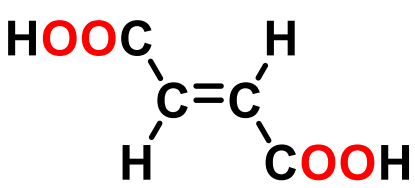
(olajsav, oleinsav, *cisz*-oktadec-9-énsav)
- 

(benzoesav, benzolkarbonsav)

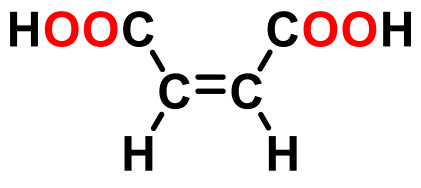
sokszínű kémia

KARBONSAVAK – FONTOSABB PÉLDÁK

- HOOC-COOH (oxálsav, etándisav)
- $HOOC\text{-}CH_2\text{-}CH_2\text{-}COOH$ (borostyánkősav, butándisav)



fumársav
transz



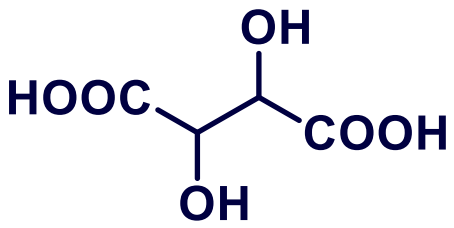
maleinsav
cisz

- $HOOC\text{-}(CH_2)_4\text{-}COOH$ (adipinsav, hexándisav)

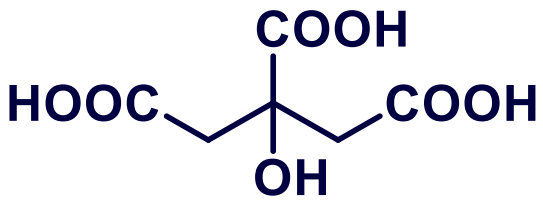
- $CH_3\text{-}CH(OH)\text{-}COOH$ (tejsav, 2-hidroxipropánsav)

sokszínű kémia

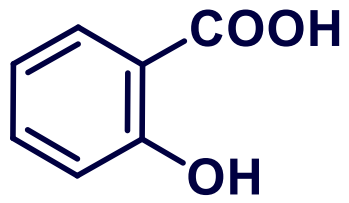
KARBONSAVAK – FONTOSABB PÉLDÁK

- 

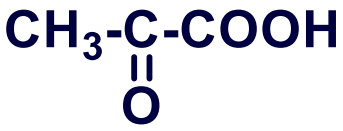
(borkősav, 2,3-dihidroxibutándisav)

- 

(citromsav, 2-hidroxipropán-1,2,3-trikarbonsav)

- 

(szalicilsav, 2-hidroxibenzoesav)

- 

(piroszőlősav, 2-oxopropánsav)

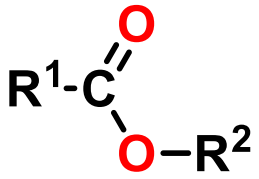
sokszínű kémia

7

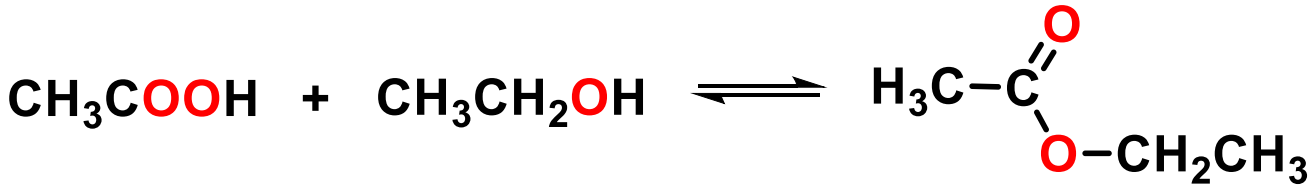
ÉSZTEREK

ÉSZTEREK

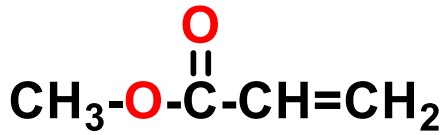
NEVEZÉKTAN: alkoholok és fenolok (helyettesített) szénhidrogén-csoportjának neve + sav savmaradékának neve alkil-alkanoát



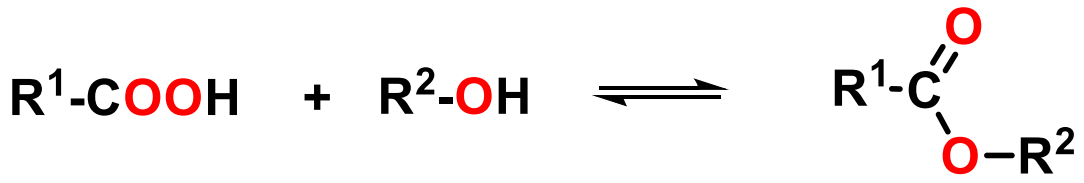
észtercsoport



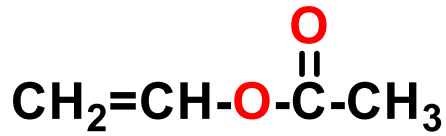
etil-acetát



metil-akrilát



karbonsav alkohol karbonsavészter

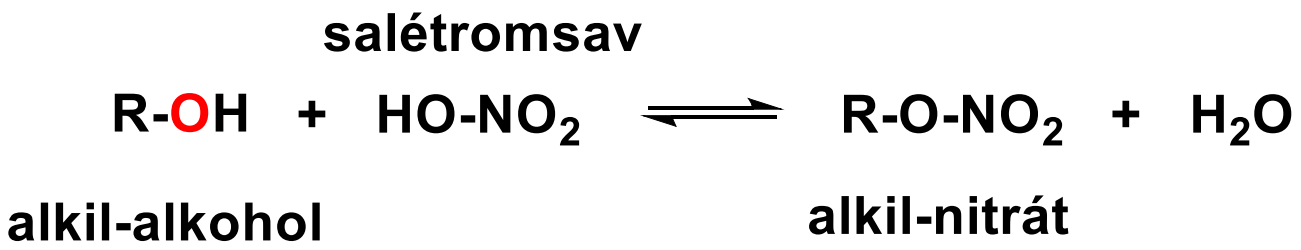


vinil-acetát

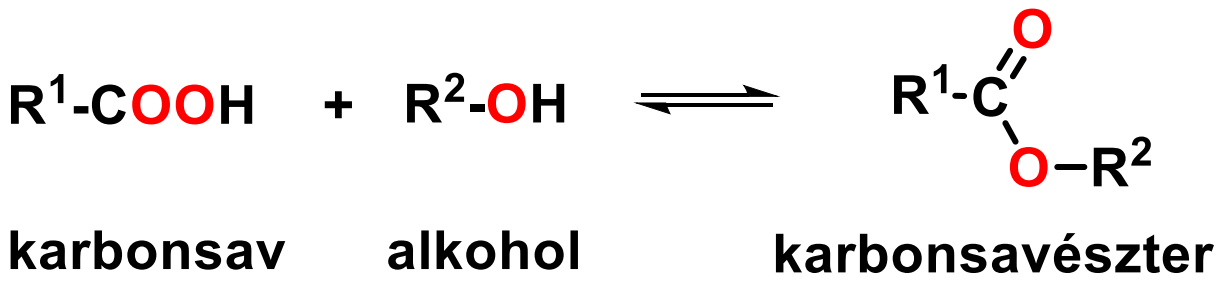
sokszínű kémia

ÉSZTEREK

- **Szervetlensav-észterek: hidroxivegyületek+szervetlen oxosavak (pl. kénsav, salétromsav, foszforsav)**

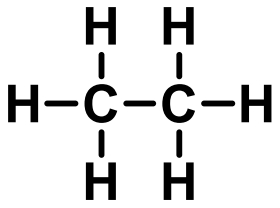


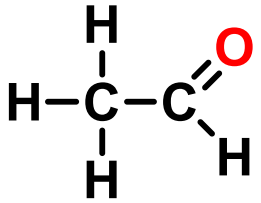
- **Szerves:**

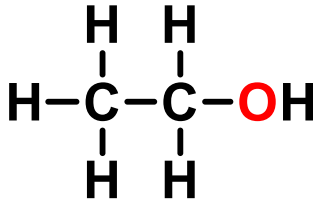


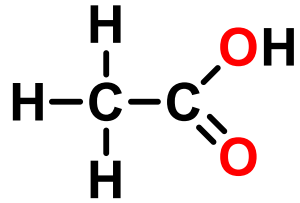
sokszínű kémia

ÉSZTEREK – FIZIKAI TULAJDONSÁGOK

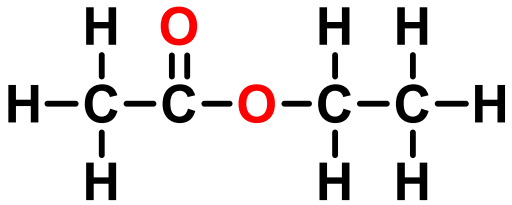


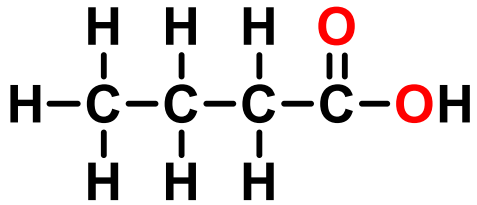






forráspont:	**-89°C**	**20°C**	**78°C**	**118°C**

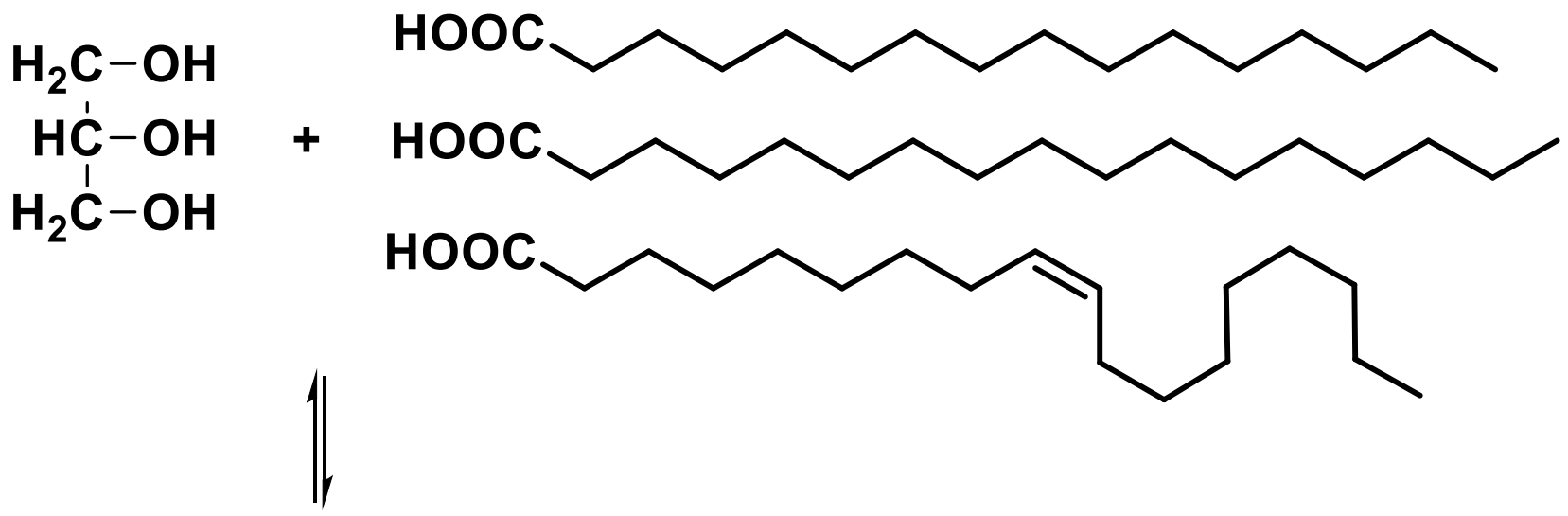


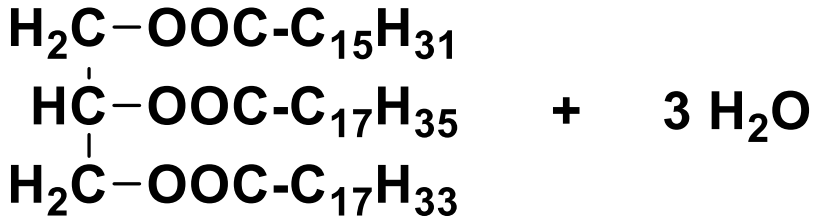


forráspont:	**77°C**	**164°C**

sokszínű kémia

GLICERIDEK





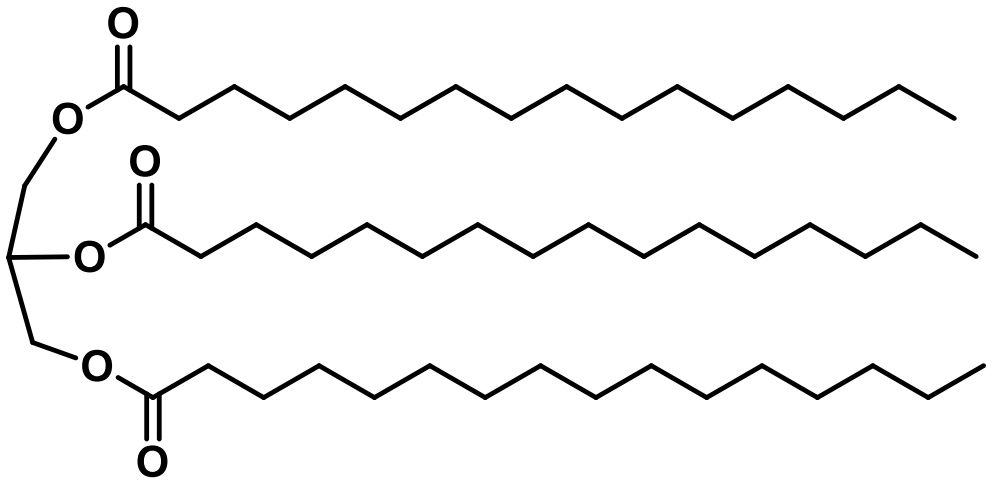
+ 3 H_2O

Zsírok, olajok

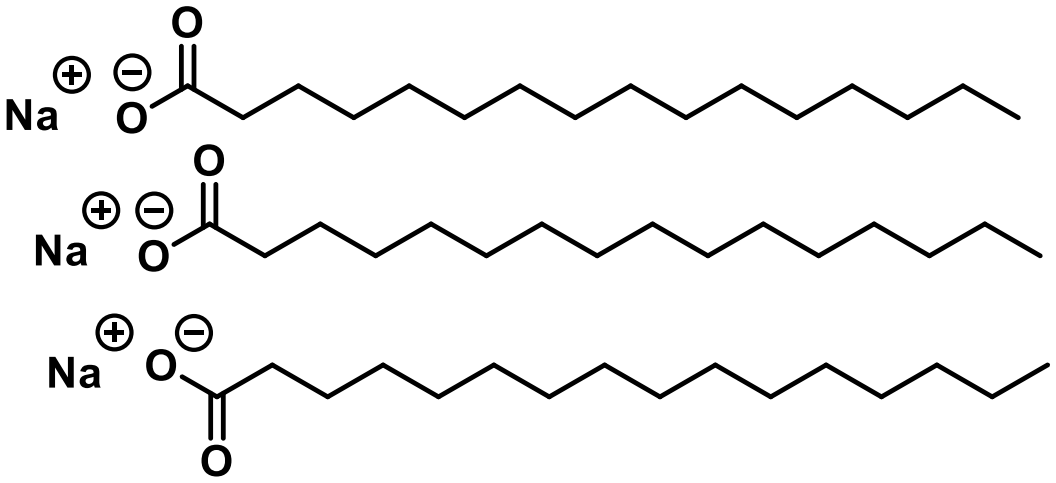
triglicerid

sokszínű kémia

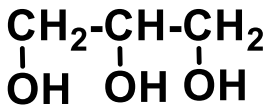
GLICERIDEK



NaOH



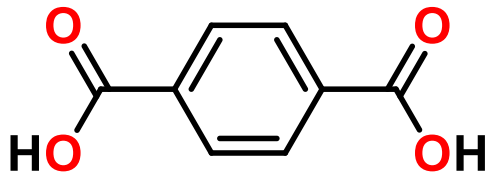
+



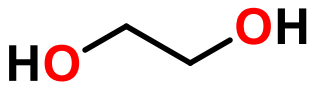
lúgos hidrolízis
elszappanosítás

sokszínű kémia

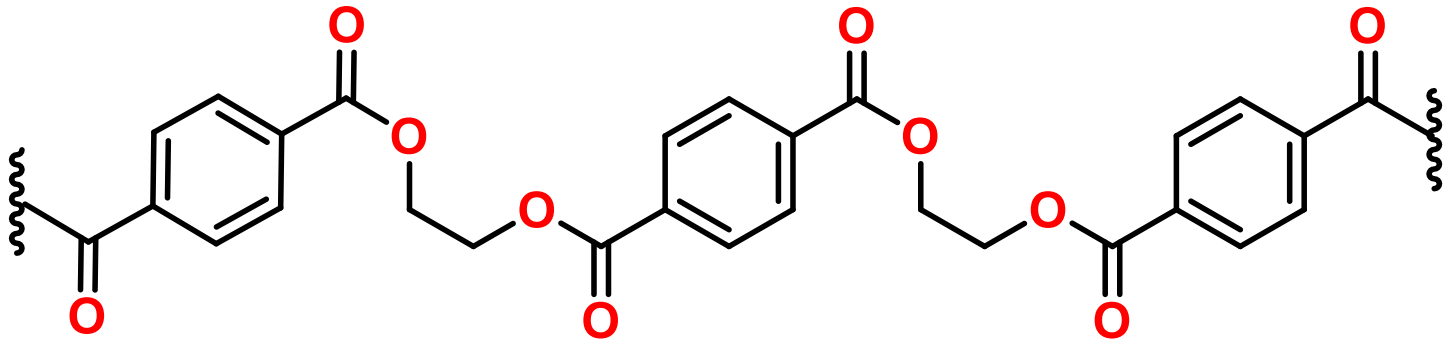
POLIÉSZTEREK



tereftálsav



etilén-glikol



polietilén-tereftalát (PET)

sokszínű kémia

KÖSZÖNÖM A FIGYELMET!