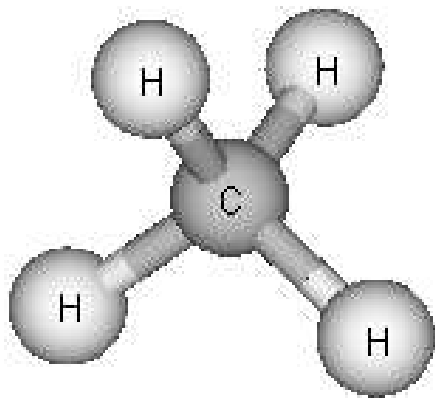
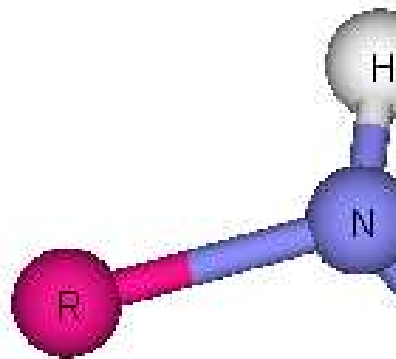


Úvod do chemie organických sloučenin

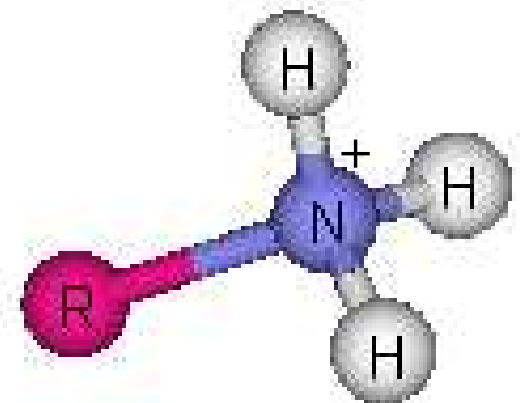
Vaznost – počet kovalentních vaz



Methan CH_4



alkylamin $R-\bar{N}H_2$



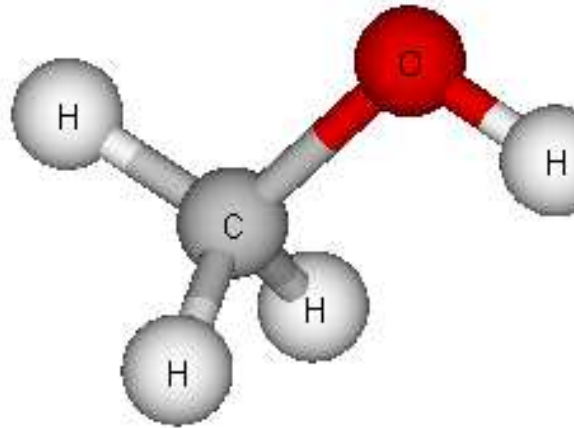
alkylamonium $R-N^+H_3$

Vodík (H) - 1

Uhlík (C) - 4

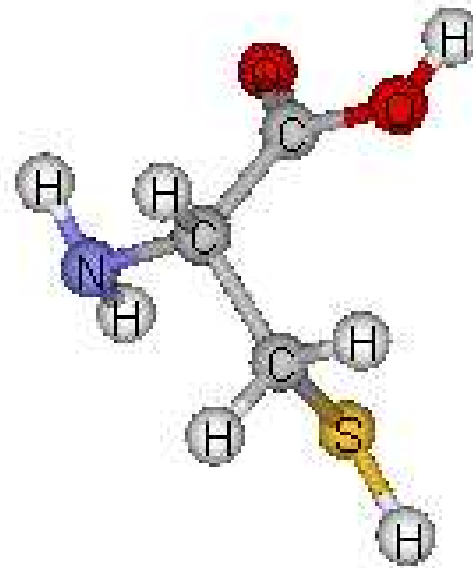
Dusík (N)

Vznost prvku



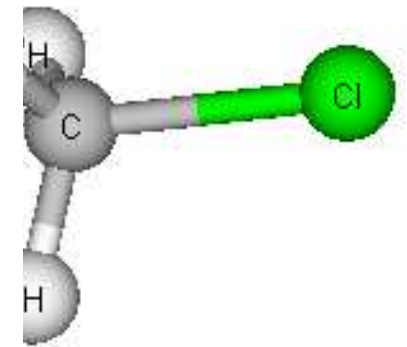
methanol (CH₃—O—H)

Kyslík (O) - 2



cystein

Síra (S) - 2

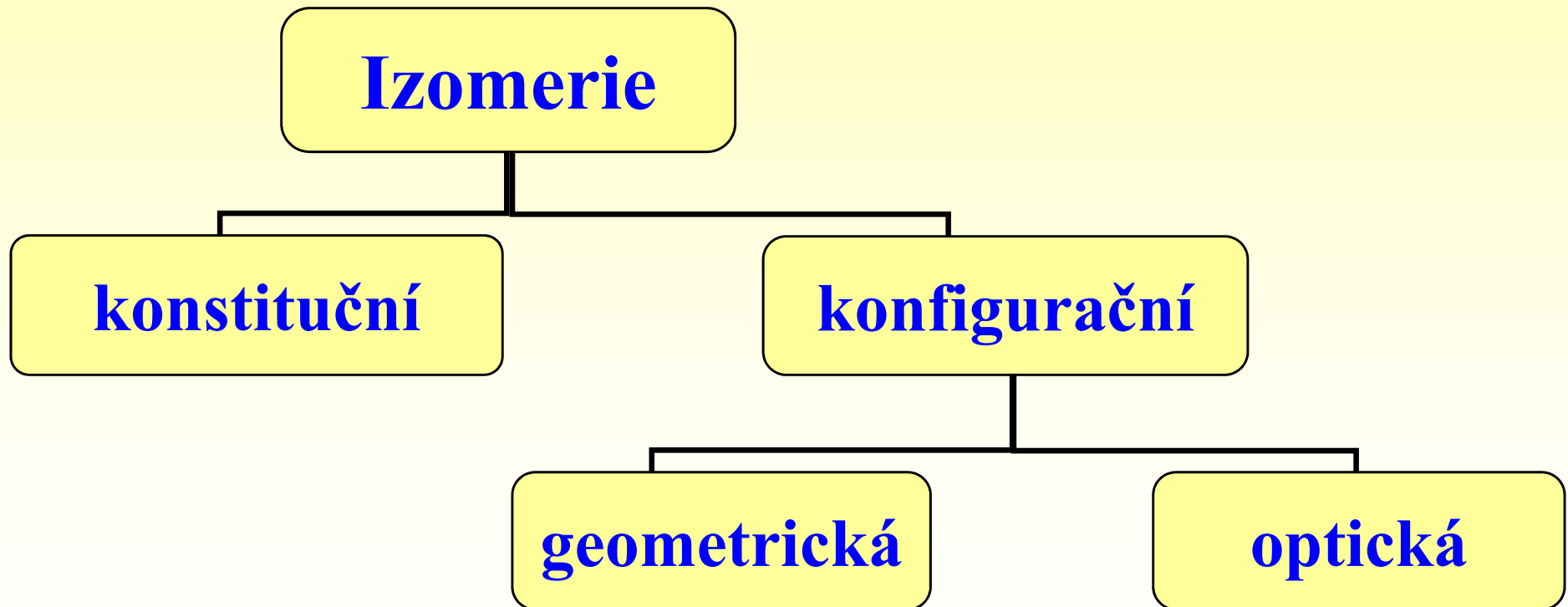


methylchlorid

Chór (Cl) - 1

Izomerie

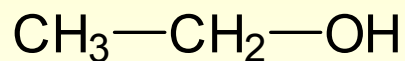
různé sloučeniny, ale stejný molekulový vzorec
(např. pro glukosu $C_6H_{12}O_6$)



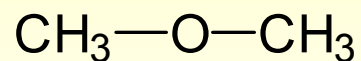
Konstituční izomerie

Konstituce – druh *atomů* i *vazeb* v molekule,
bez prostorového uspořádání

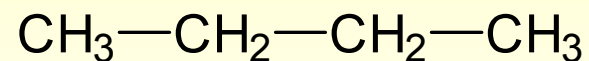
Molekulový (sumární) vzorec:



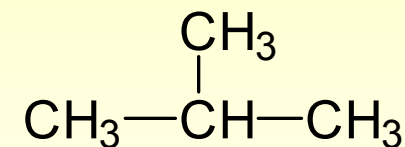
ethanol



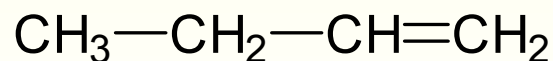
dimethylether



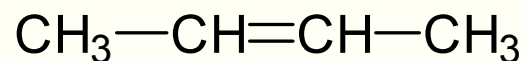
butan



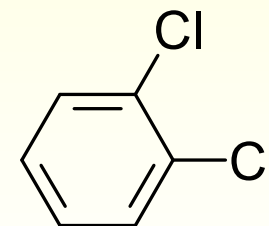
2-methylpropan



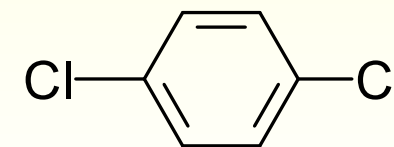
but-1-en



but-2-en



1,2-dichlorbenzen



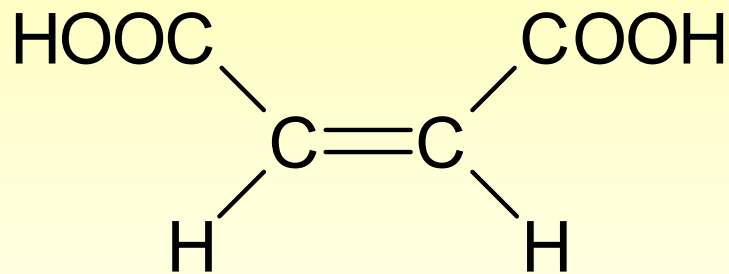
1,4-dichlorbenzen



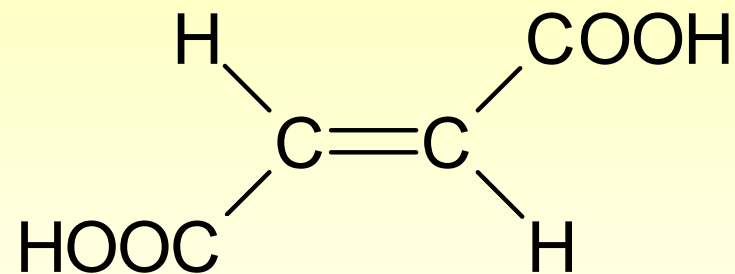
Konfigurační izomerie

- **Konfigurace** – prostorové uspořádání všech atomů a vazeb bez ohledu na rotaci kolem jednoduchých vazeb
- **Konfigurační izomery** – mají stejnou konstituci, liší se však konfigurací
 - Geometrická izomerie (*cis/trans*)
 - Optická izomerie – (D/L)

Geometrická (*cis/trans*) izomerie



cis-but-2-endiová kyselina
(maleinová)



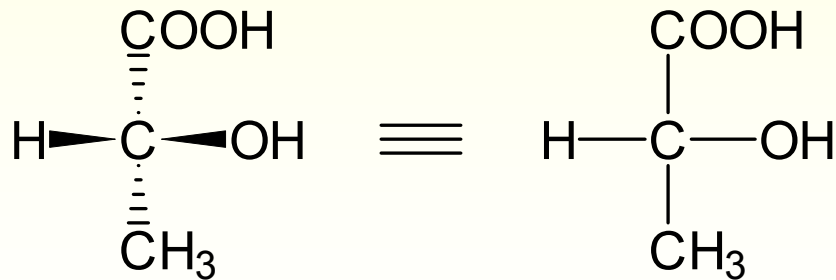
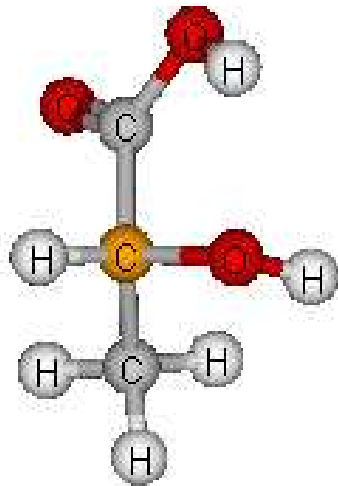
trans-but-2-endiová kyselina
(fumarová)

meziprodukt citrátového cyklu

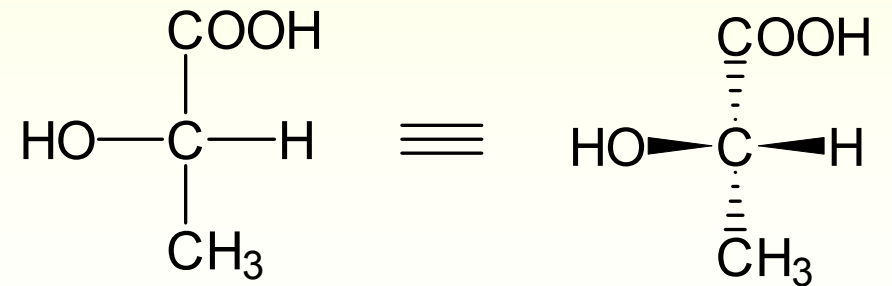
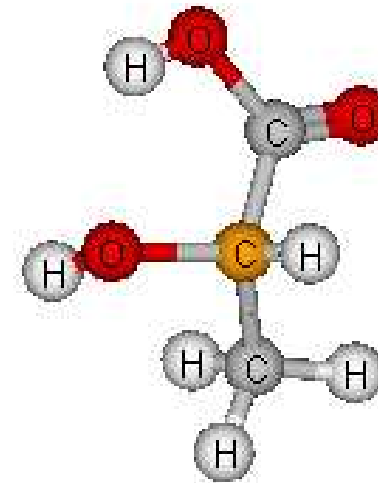
Optická izomerie

Rovina

symetrie



D-mléčná kyselina

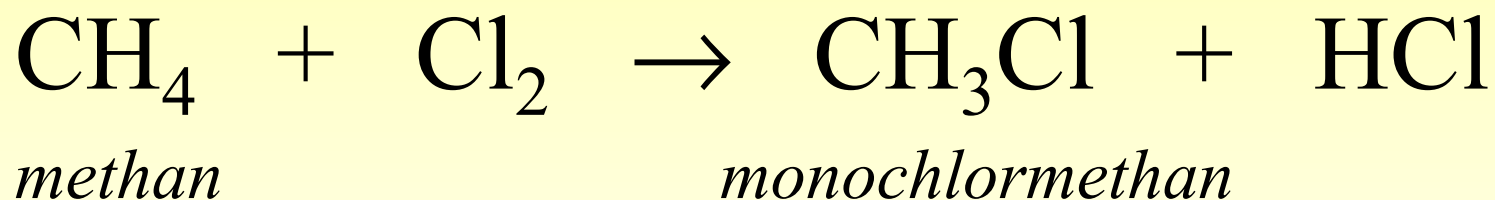


L-mléčná kyselina

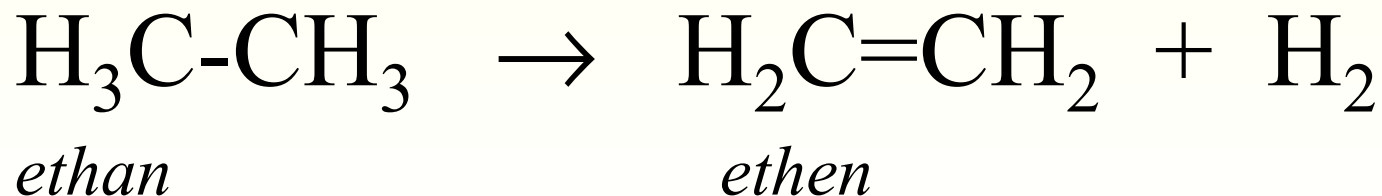
produkt glykolýzy za anaerobních podmínek ⁷

Typy reakcí

1. **Substituce** (nahrazování)

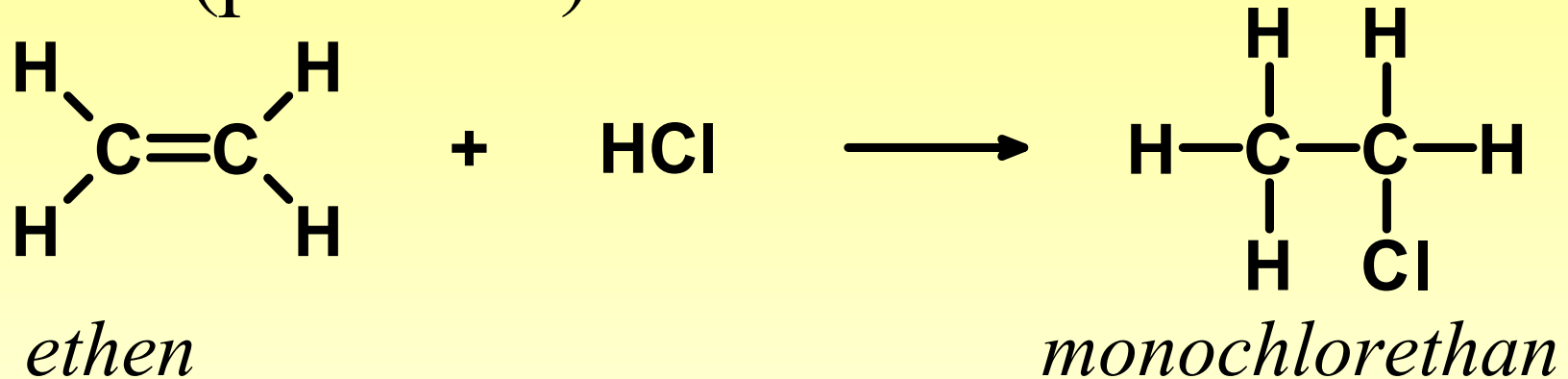


2. **Eliminace** (odebírání)

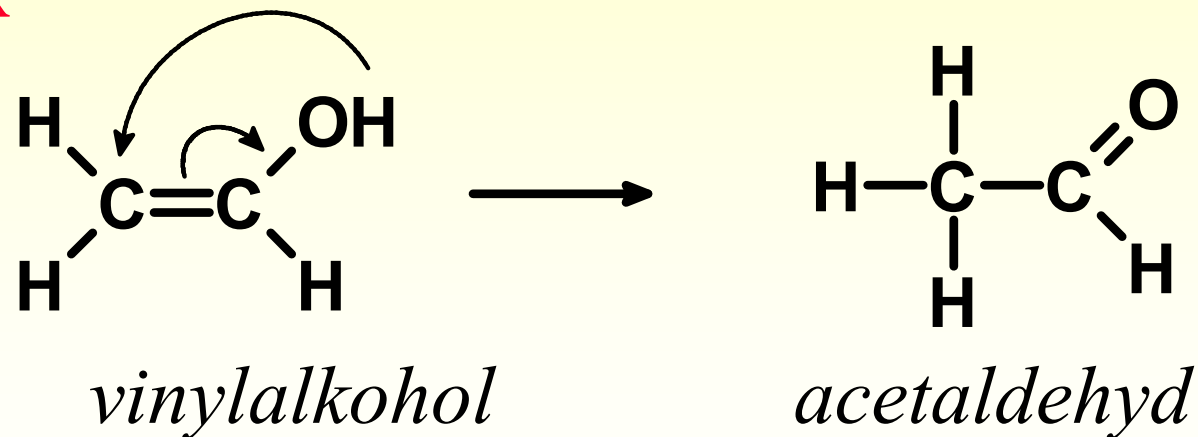


Typy reakcí

3. **Adice** (přidávání)



4. **Přesmyk**



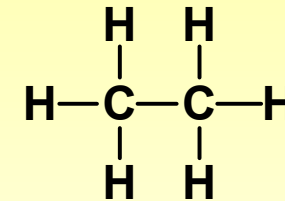
izomery (tautomery)

Uhlovodíky

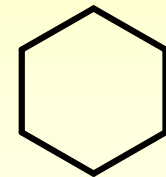
- obsahují pouze atomy C a H

Typ uhlovodíku

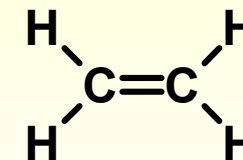
alkany (nasycené uhlovod.)



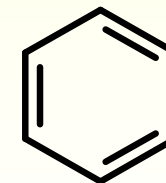
cykloalkany (cyklické a nasycené)



alkeny (dvojné vazby)



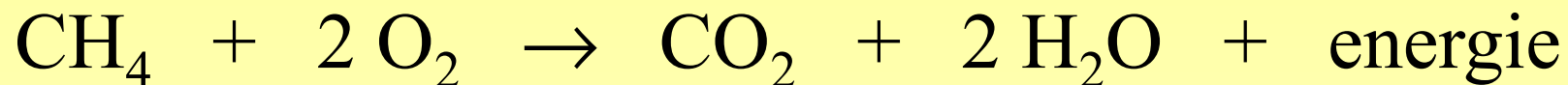
areny (aromatické uhlovod.)



Příklad

• Oxidace

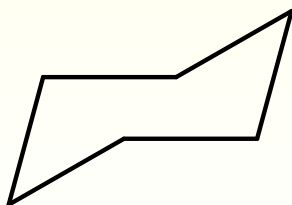
- hoření (např. spalování methanu, benzínů)



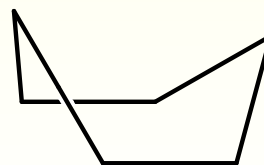
- částečná (produktem může být i CO)

Cykloalkany

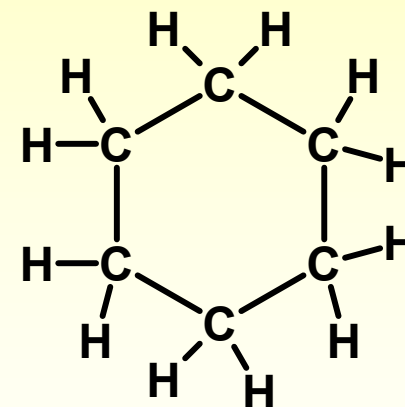
- nejstabilnější jsou s 5 a 6 C v cyklu
- židličková a vaničková konformace cyklohexanu



židlička

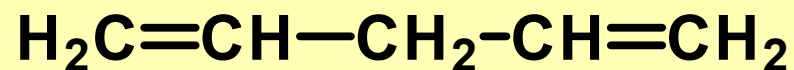


vanička

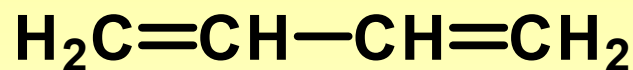


Nenasycené uhlovodíky (alkeny)

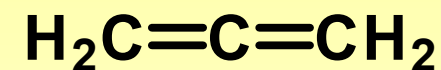
- alkeny obsahují dvojně vazby
- alkadieny - 2 dvojně vazby



izolované

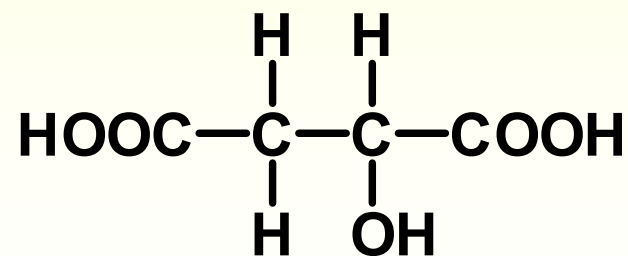
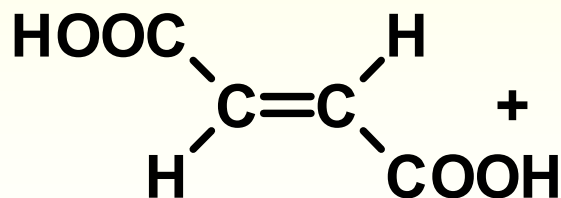
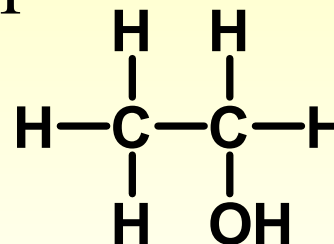
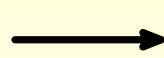
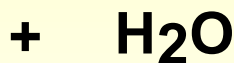
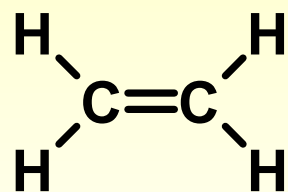


konjugované



kumulované

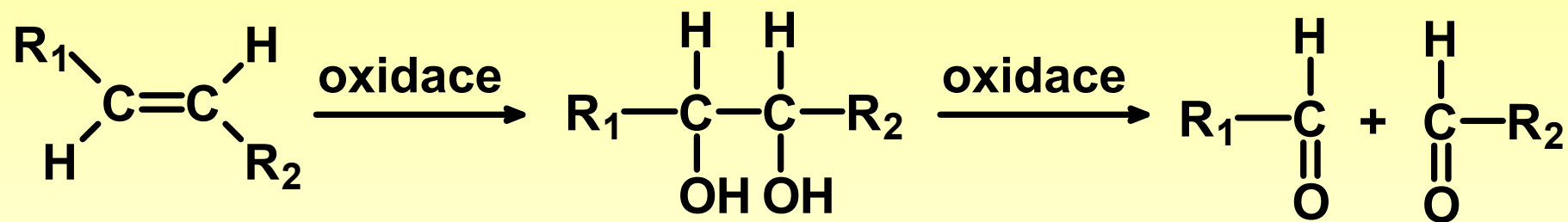
- jsou **reaktivnější než alkany**, typická reakce **adice**



kys. fumarová

kys. jablečná

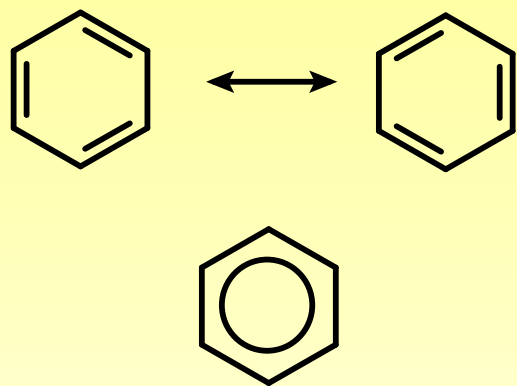
- oxidace (snadněji než u alkanů)



vicinální diol

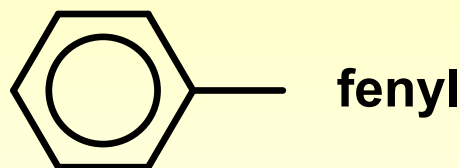
aldehydy

Aromatické uhlovodíky (areny)

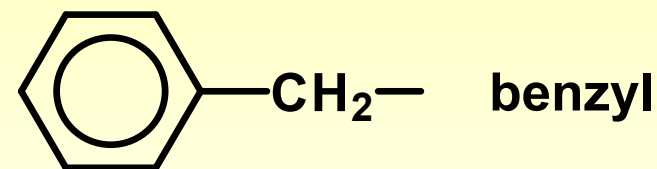


benzen

- atomy C a H leží v jedné rovině
- na C hybridizace sp^2
- vazby C-C jsou rovnocenné
- dokonalá delokalizace π -elektronů



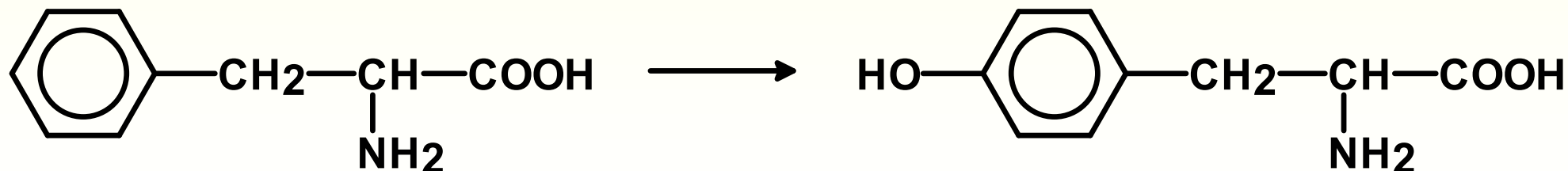
fenyl



benzyl

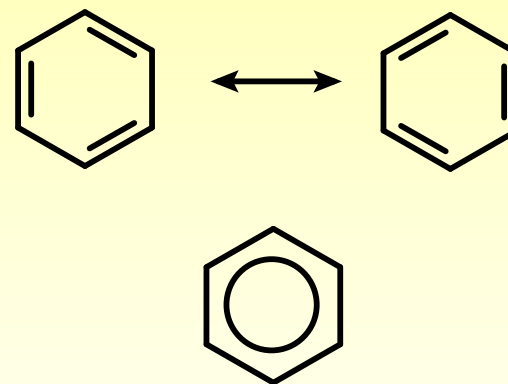
- typická reakce **substituce**, adice (oxidace) nesnadno

Př. hydroxylace



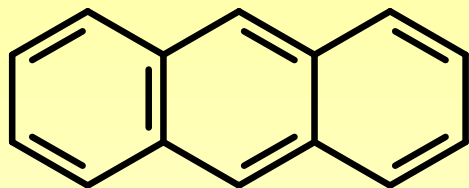
Benzen

- Atomy C – hybridizace sp^2
- Všechny atomy uhlíku a vodíku leží v jedné rovině

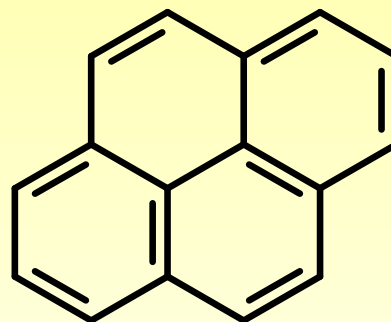


benzen

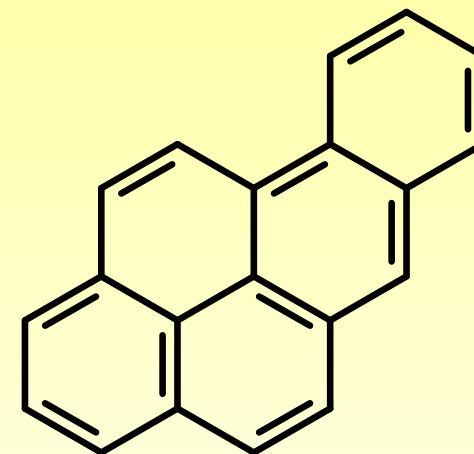
Polykondenzované aromatické uhlovodíky (PAH)



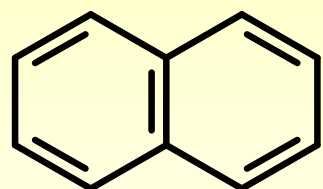
anthracen



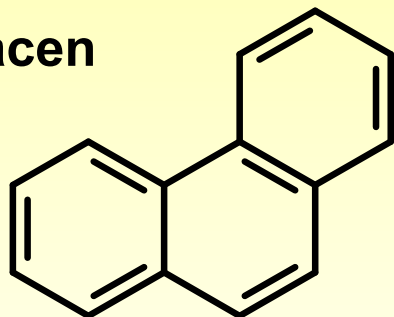
pyren



benzo[a]pyren



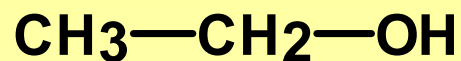
naftalen



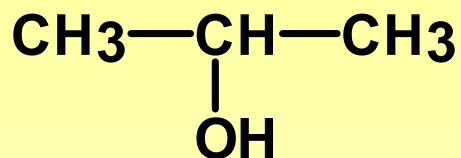
fenanthren

- jsou **kancerogenní (=karcinogenní)**
- cigaretový kouř, výfukové plyny, dehet, saze a smažené, uzené, připálené potraviny

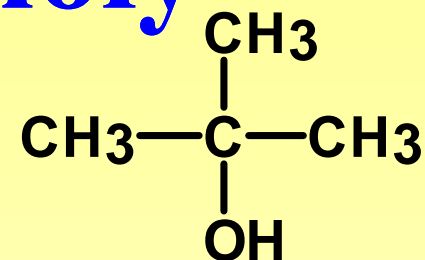
Alkoholy a fenoly



ethanol
(primární alk.)



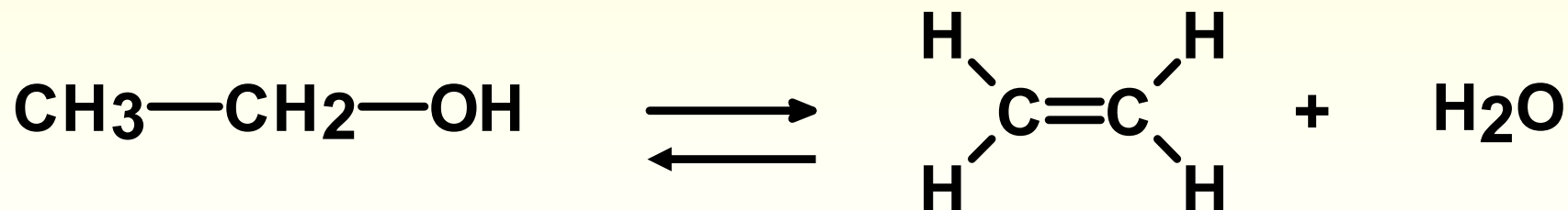
2-propanol
(sekundární alk.)



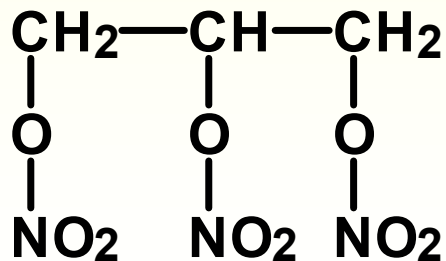
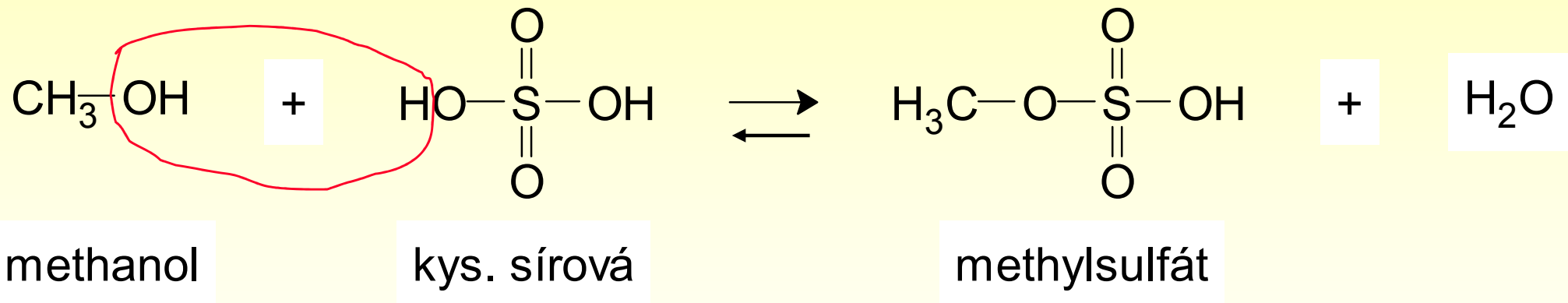
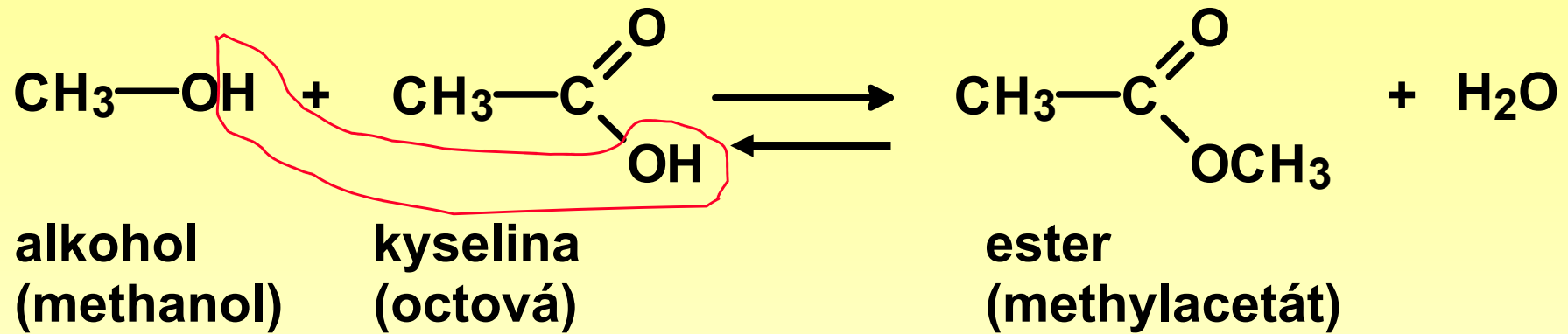
2-methyl-2-propanol
(terciární alkohol)

Reakce:

- Dehydratace

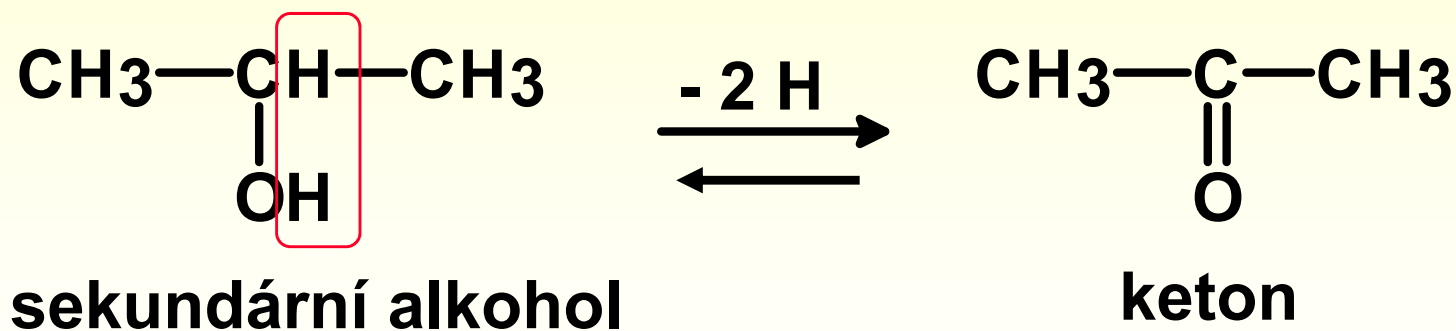
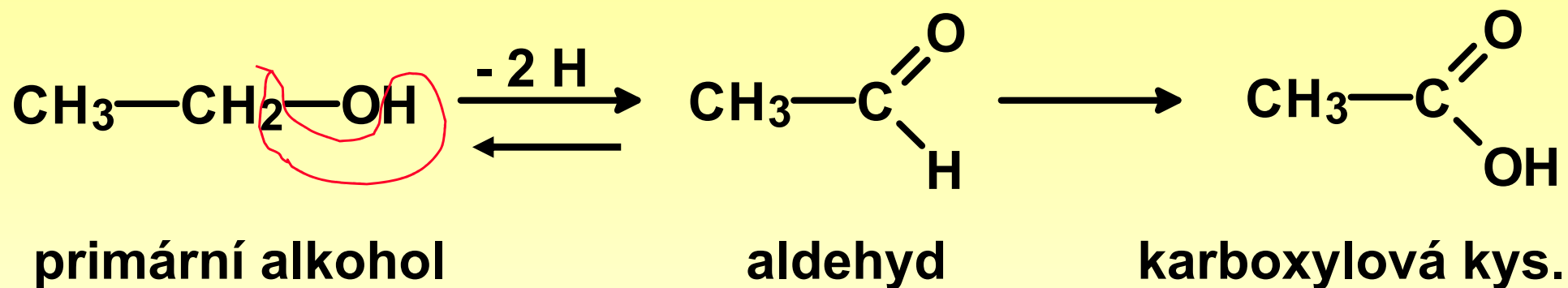


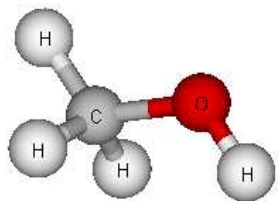
• Esterifikace



Glyceroltrinitrát - vazodilatans
účinek prostřednictvím NO

- Oxidace (dehydrogenace)**

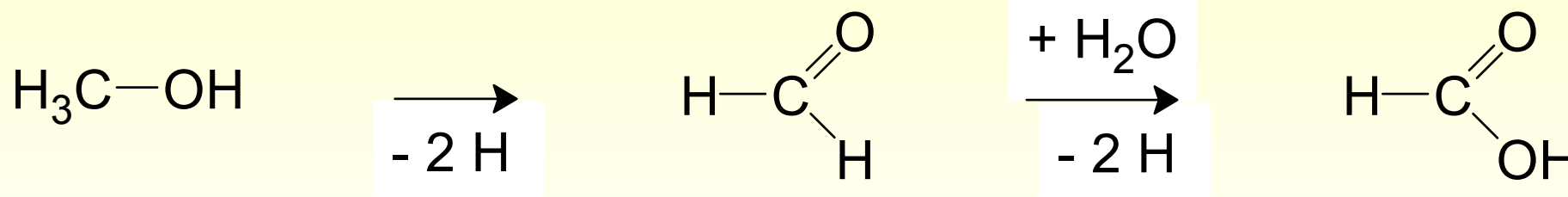




Methanol (CH₃OH)



- kapalina alkoholové vůně a chuti, mísitelná s vodou – průmyslové rozpouštědlo
- oxiduje se na formaldehyd a mravenčí kyselinu



- **značně neurotoxický**, poškození zrakového nervu
- antidotum ethanol (přednostně se oxiduje v organismu)

Ethanol (CH₃CH₂OH)

- obsažen v alkoholických nápojích
- oxiduje se na acetaldehyd a octovou kyselinu
- **alkohol v krvi:** (‰) = $m / (h * f)$

m hmotnost ethanolu v g

h tělesná hmotnost v kg

f 0,67 muži, 0,55 ženy

pokles:

0,15 ‰ / hod

Koncentrace alkoholu v krvi

> 0,3 ‰ - vždy znamená požití alkoholu

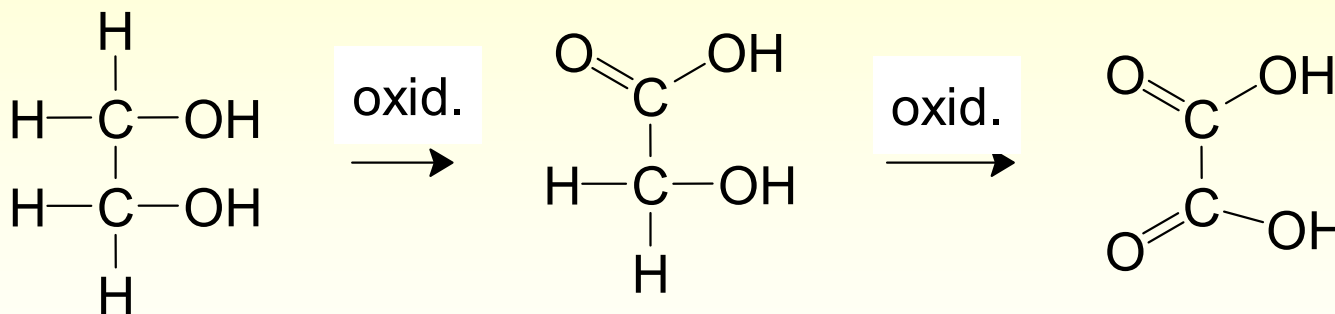
0,5 - 1,5 ‰ - lehká opilost, 2 - 3 ‰ - těžká opilost,

3 - 4 ‰ - bezvědomí, smrtelná dávka **150 -250 g**



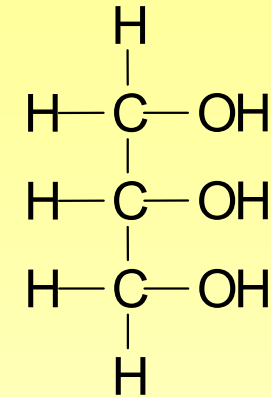
Ethylenglykol (HO-CH₂-CH₂-OH)

- nasládlá viskózní kapalina
- přísada do nemrznoucích směsí - „FRIDEX“
- oxiduje se na šťavelovou kyselinu

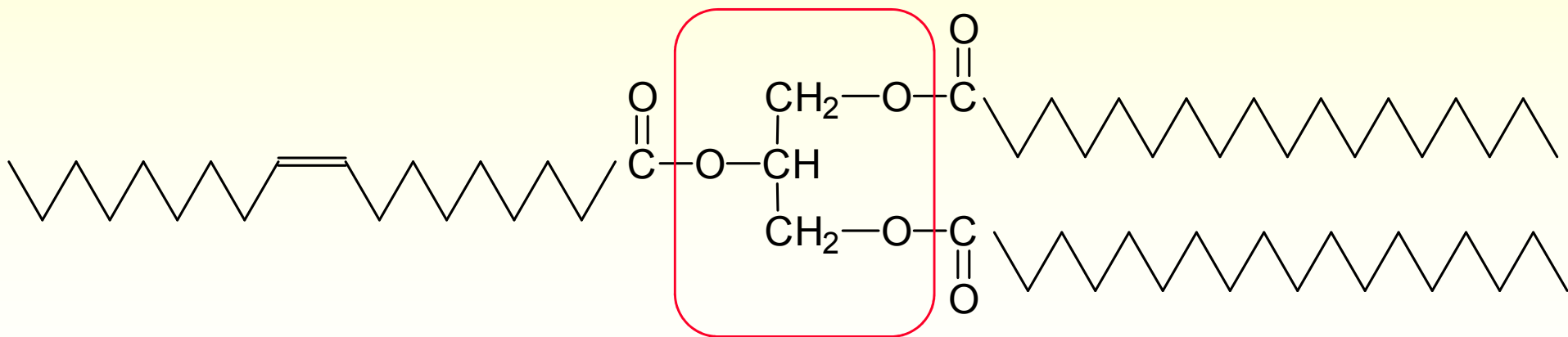


- způsobuje **těžkou acidózu a selhání ledvin** (Ca-oxalát)
- antidotum ethanol

Glycerol

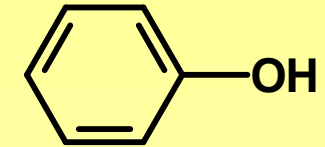


- Sirupovitá nasládlá kapalina
- **Součást triacylglycerolů a glycerolfosfolipidů**
- **Je hygroskopický** – kosmetika, glycerinové čípky



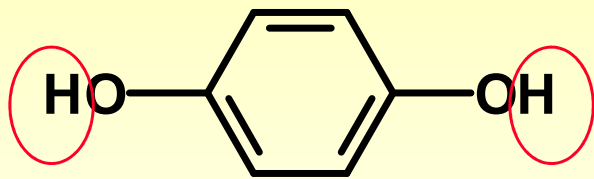
triacylglycerol

Fenoly

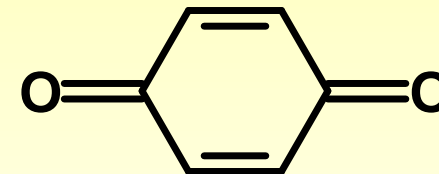
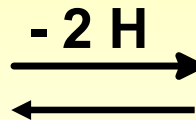


fenol

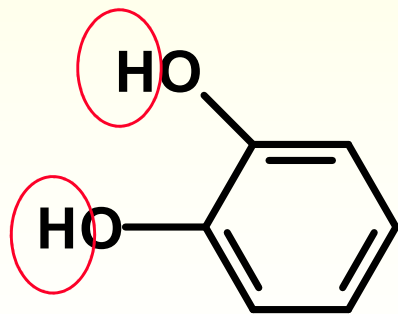
- na rozdíl od alkoholů jsou velmi slabé kyseliny
- dávají podobné reakce jako alkoholy
- **oxidace**



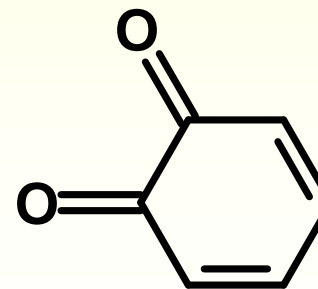
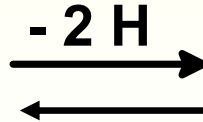
1,4-benzendiol



1,4-benzochinon

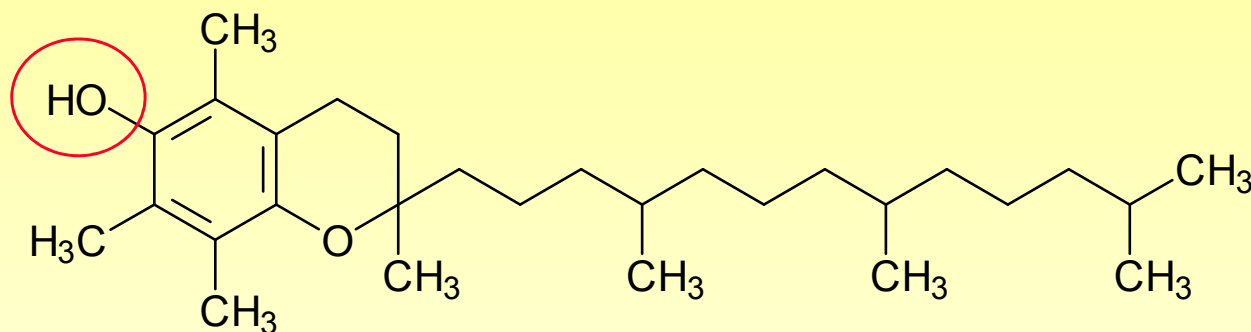


1,2-benzendiol

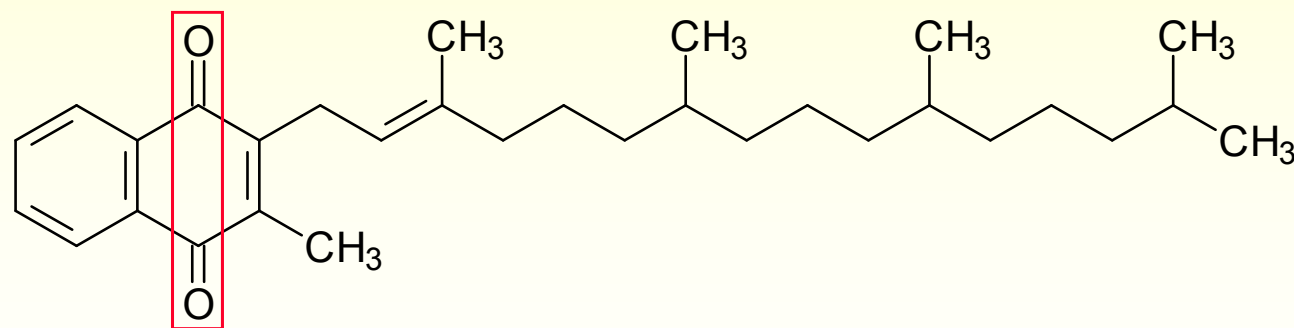


1,2-benzochinon

Biogenní fenoly a chinony

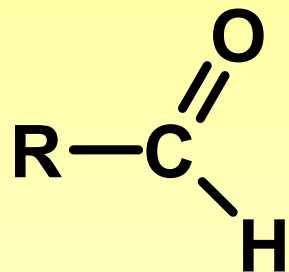


Tokoferol - vitamin E

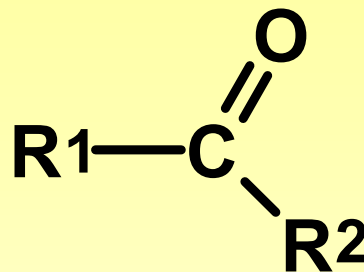


Fylochinon - vitamin K

Aldehydy a ketony



aldehyd

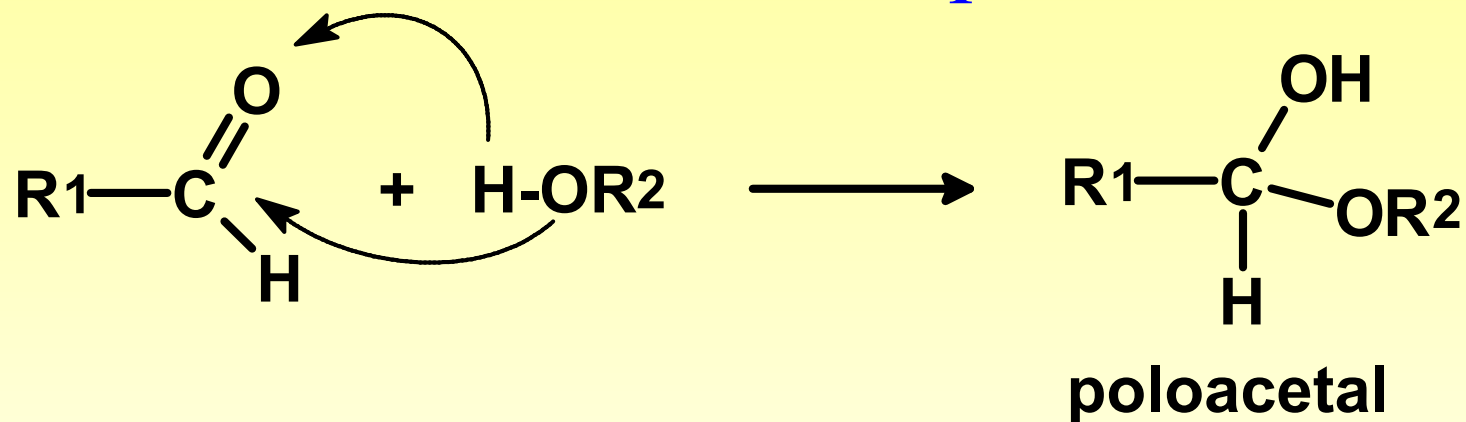


keton

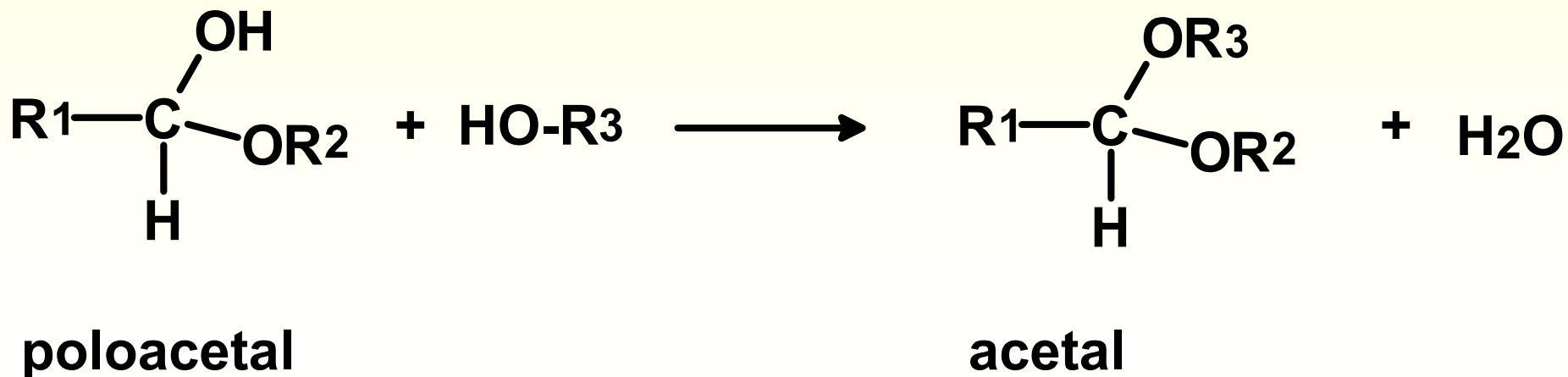
- Jsou reaktivnější než alkoholy
- typická je **adice na polární vazbu C=O**
- aldehydy se oxidují na karboxylové kyseliny

Reakce aldehydů a ketonů

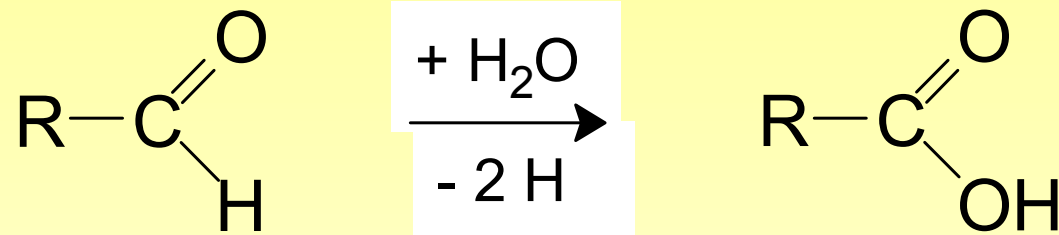
- Adice alkoholů za vzniku poloacetalu



- přeměna poloacetalu na acetal - substituce

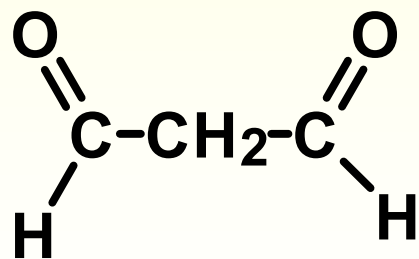


- Aldehydy se snadno oxidují na karboxyl. kyseliny



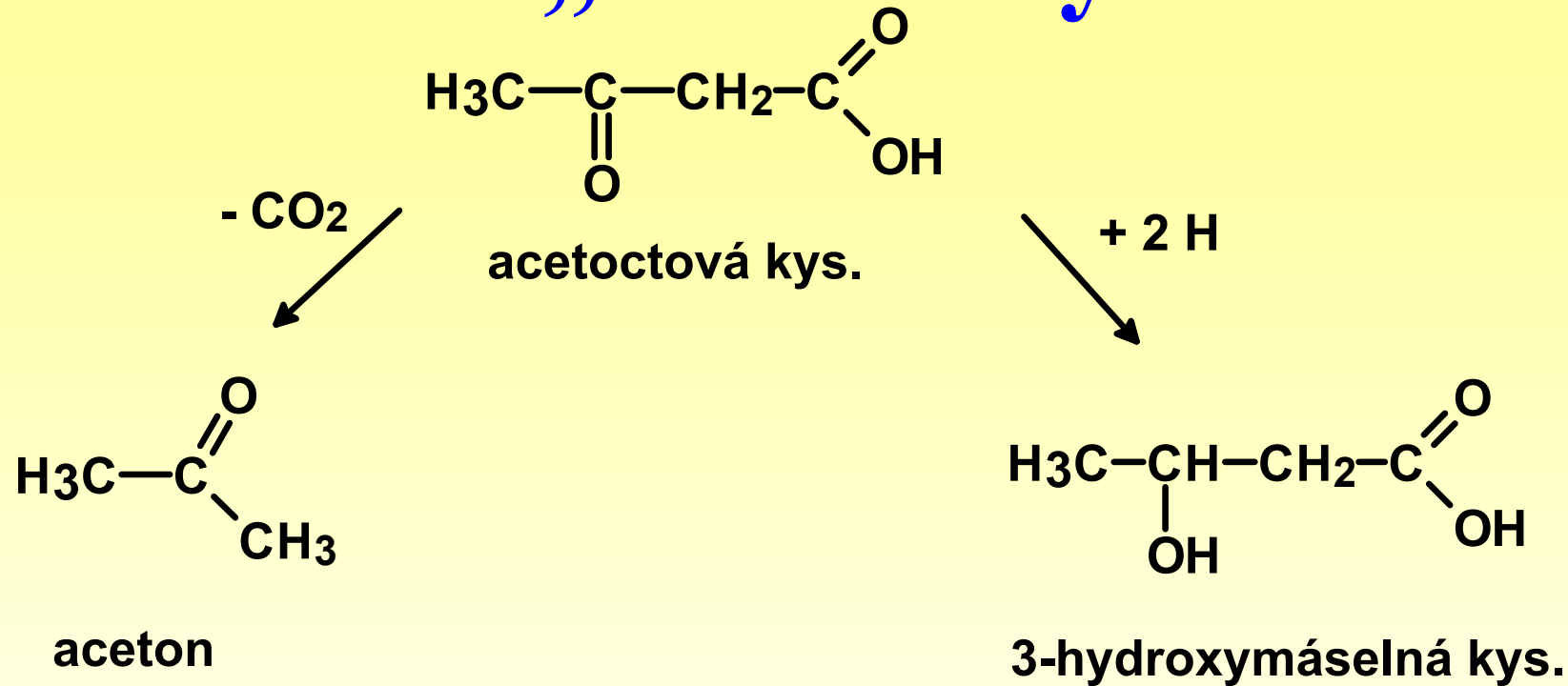
- Ketony se oxidují nesnadno

Malondialdehyd (dialdehyd kys. malonové)



- reaktivní **produkt peroxidace** (oxidace) lipidů
- vzniká z nenasycených mastných kys.

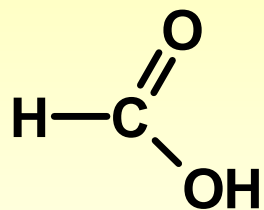
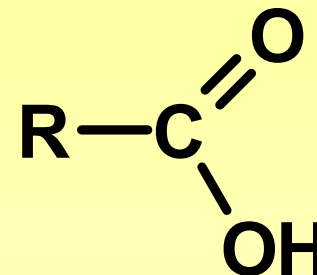
„Ketolátky“



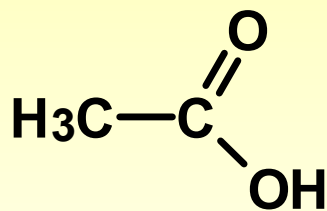
- vznikají při odbourávání tuků (mastných kyselin)
- vznikají jen v nepatrném množství v játrech
- ve zvýšené míře při zvýšeném odbourávání tuků (např. **nekompenzovaná cukrovka, hladovění**) ketoacidóza
- vylučují se močí, potem a dechem
- stanovují se v moči testem s nitroprusidem sodným

Karboxylové kyseliny

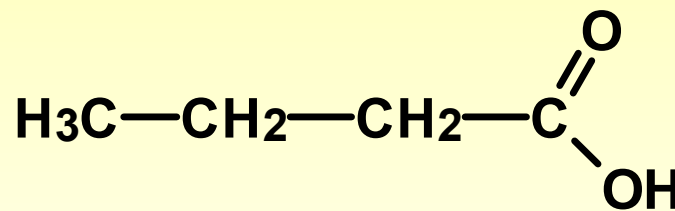
- Karboxylová skupina je polární
- jsou slabé kyseliny



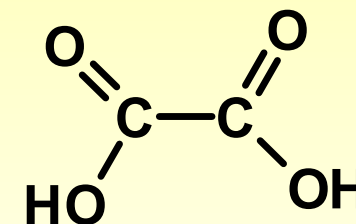
kys. mravenčí



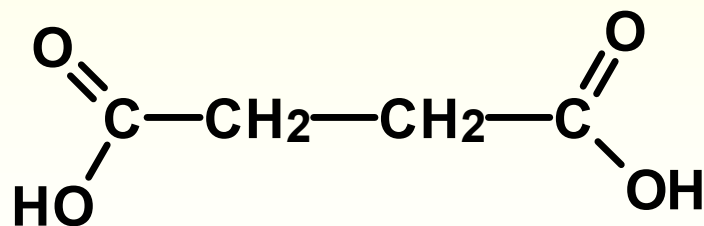
kys. octová



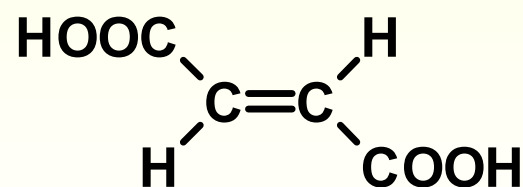
kys. máselná



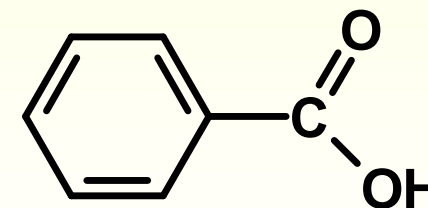
kys. šťavelová



kys. jantarová

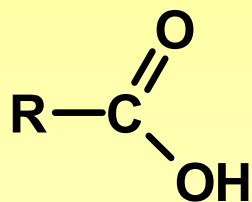


kys. fumarová

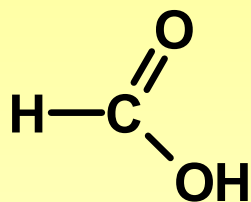


kys. benzoová

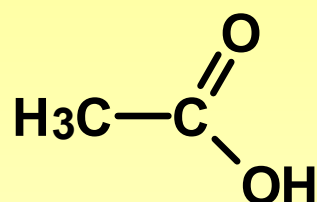
Názvy acylů karboxylových kyselin



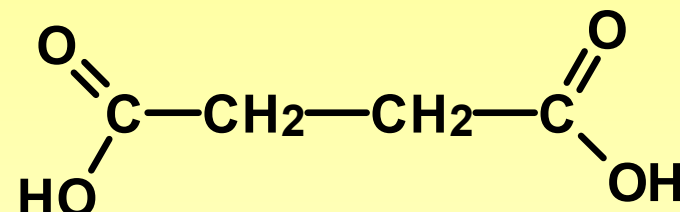
karboxylová kys.



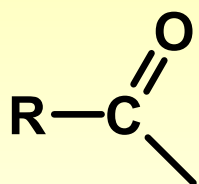
kys. mravenčí



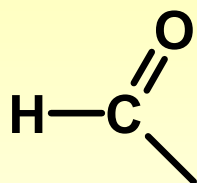
kys. octová



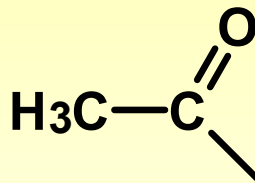
kys. jantarová



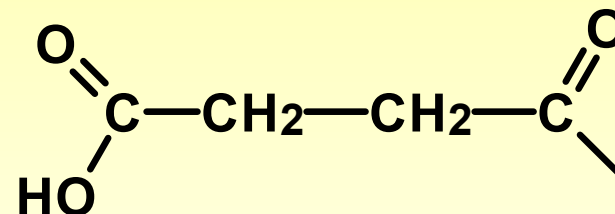
acyl



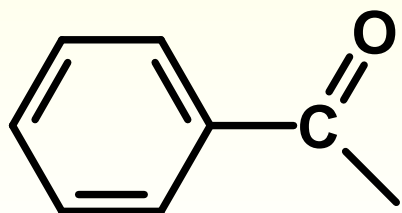
formyl



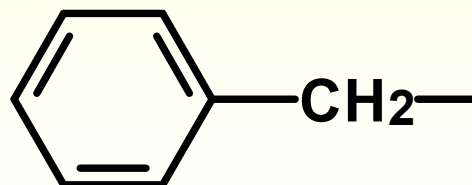
acetyl



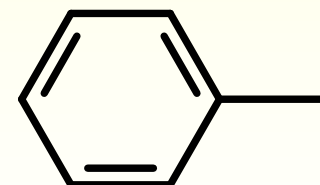
sukcinyl



benzoyl



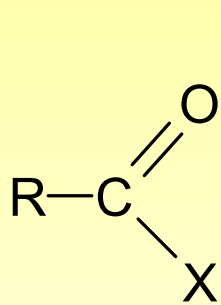
benzyl



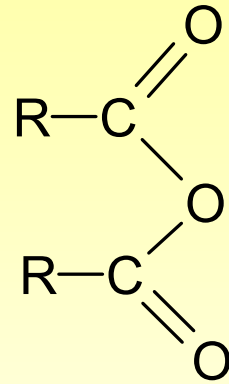
fenyl

Funkční deriváty karboxylových kyselin

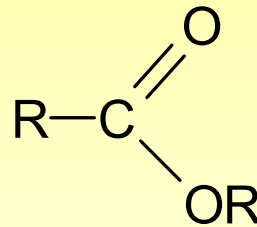
- nejsou kyselé, mohou se hydrolyzovat na karboxyl. kys.



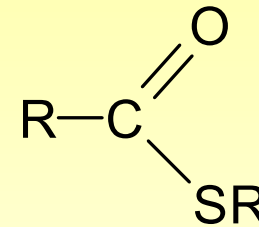
acylhalogenid



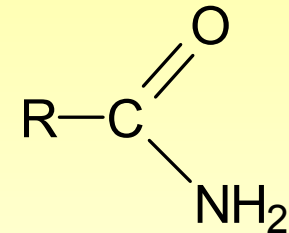
anhydrid



ester

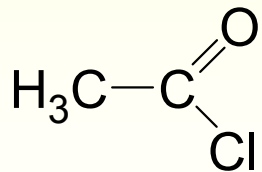


thioester

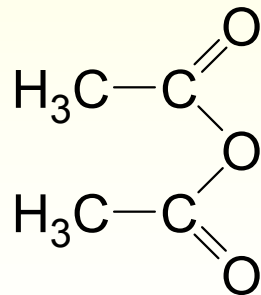


amid

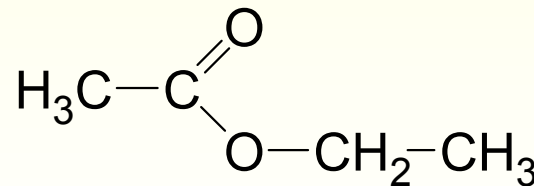
Příklady



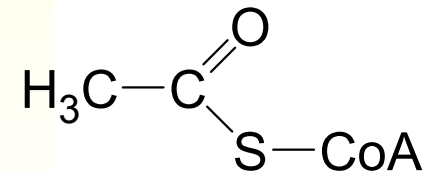
acetylchlorid



acetanhydrid

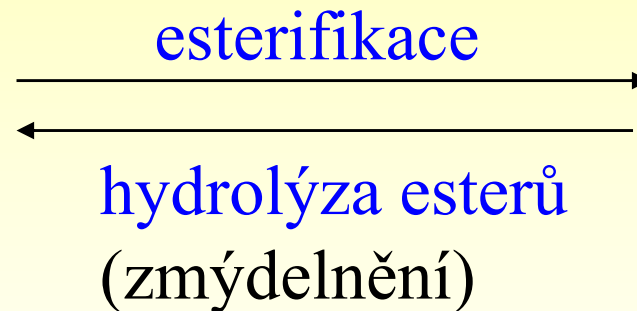
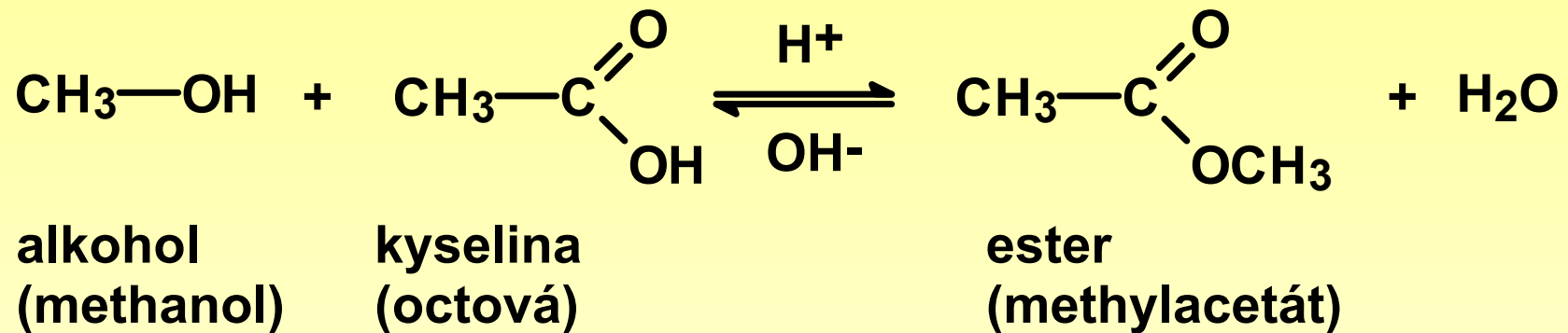


ethyl-acetát



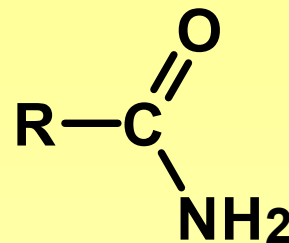
acetylkoenzym A

Estery

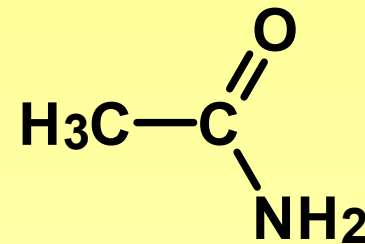


- estery jsou těkavé kapaliny většinou příjemné vůně
- **tuky** - estery glycerolu a vyšších mastných kyselin

Amidy



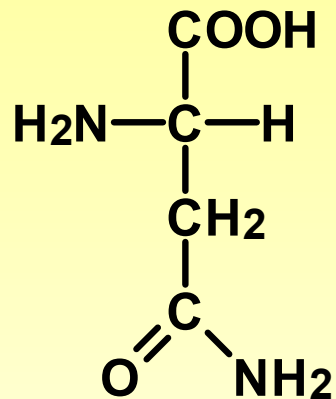
amid



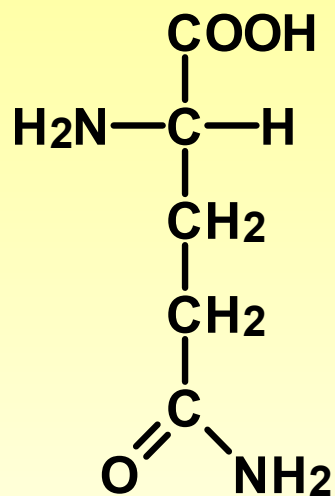
acetamid

- na rozdíl od aminů ($\text{R}-\text{NH}_2$) **nejsou bazické**
- odolnější vůči alkalické hydrolýze na rozdíl od esterů
- mezi amidy patří aminokyseliny: **asparagin** a **glutamin**
- mezi amidy patří **peptidy a bílkoviny**

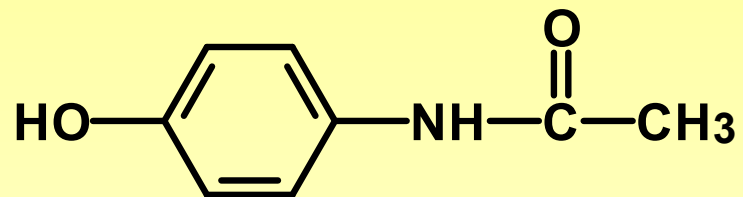
Významné amidy



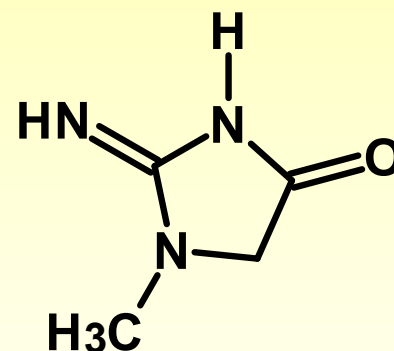
asparagin



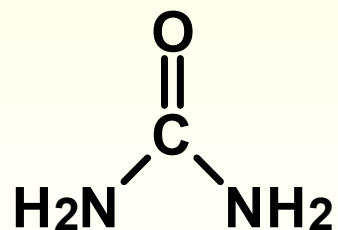
glutamin



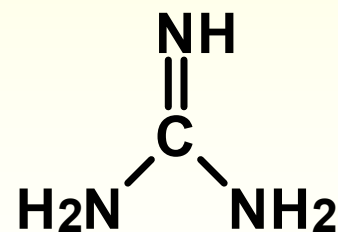
paracetamol



kreatinin
(laktam)
(intramolekulární amid)

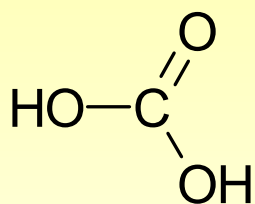


močovina
(polární)

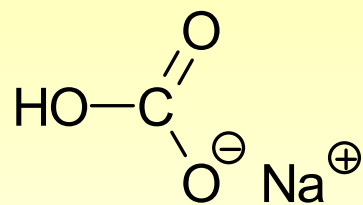


guanidin
(silná báze)

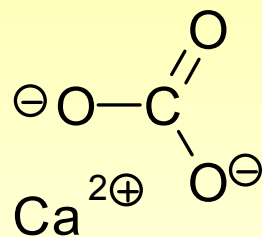
Deriváty kyseliny uhličité



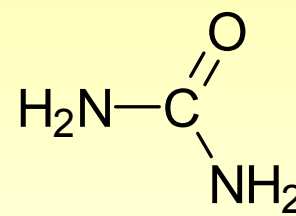
kyselina uhličitá



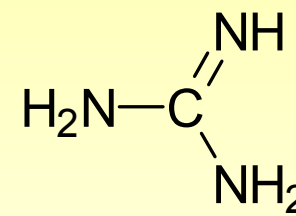
hydrogenuhličitan
sodný (NaHCO_3)



uhličitan vápenatý
(CaCO_3)



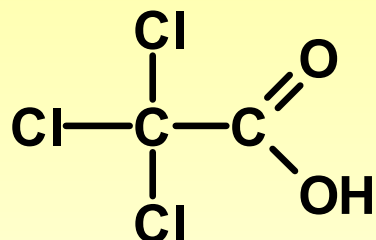
močovina



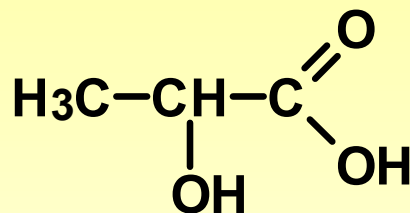
guanidin

Substituční deriváty karboxylových kyselin

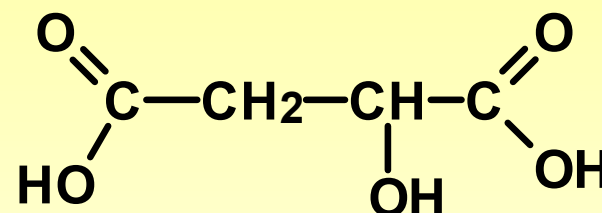
Halogenkyseliny, hydroxykyseliny



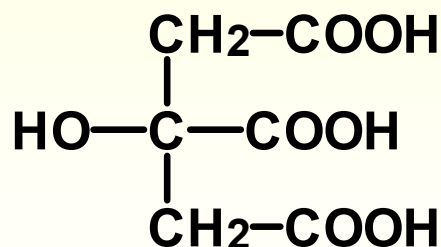
trichloroctová kys.
(př. halogenkyseliny)



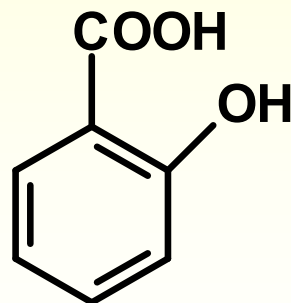
kys. mléčná
(sůl laktát)



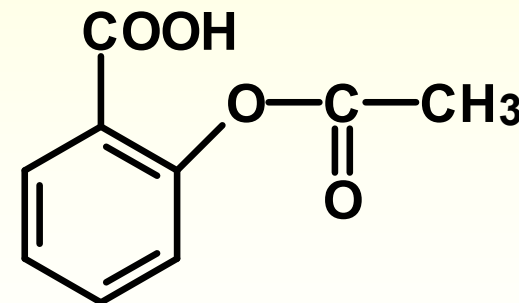
kys. jablečná
(sůl malát)



kys. citronová
(sůl citrát)

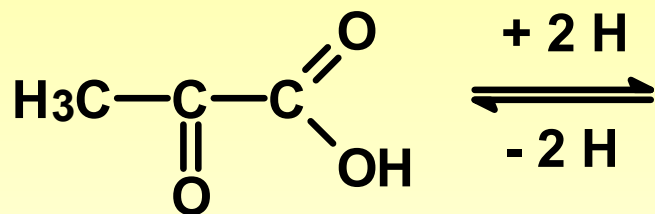


kys. salicylová
(sůl salicylát)

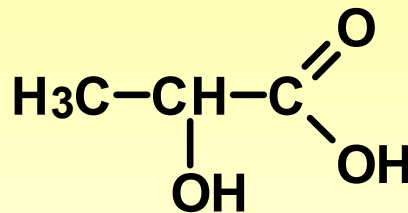
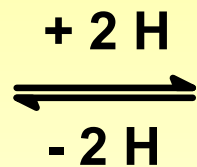


kys. acetylsalicylová

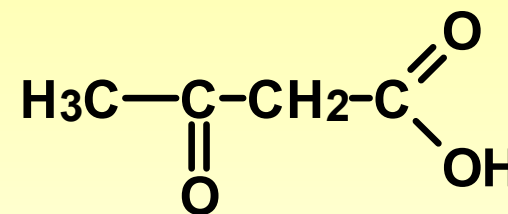
Oxokyseliny



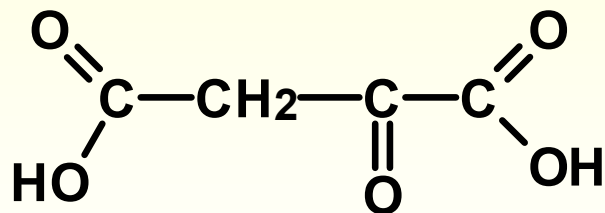
kys. pyrohroznová
(sůl pyruvát)



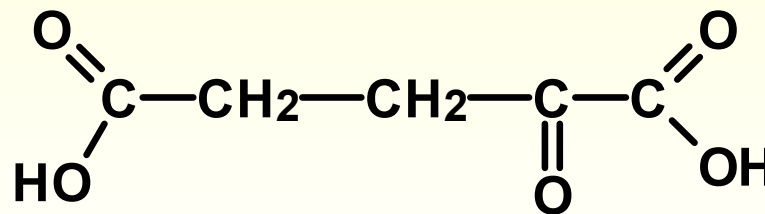
kys. mléčná



kys. acetoctová

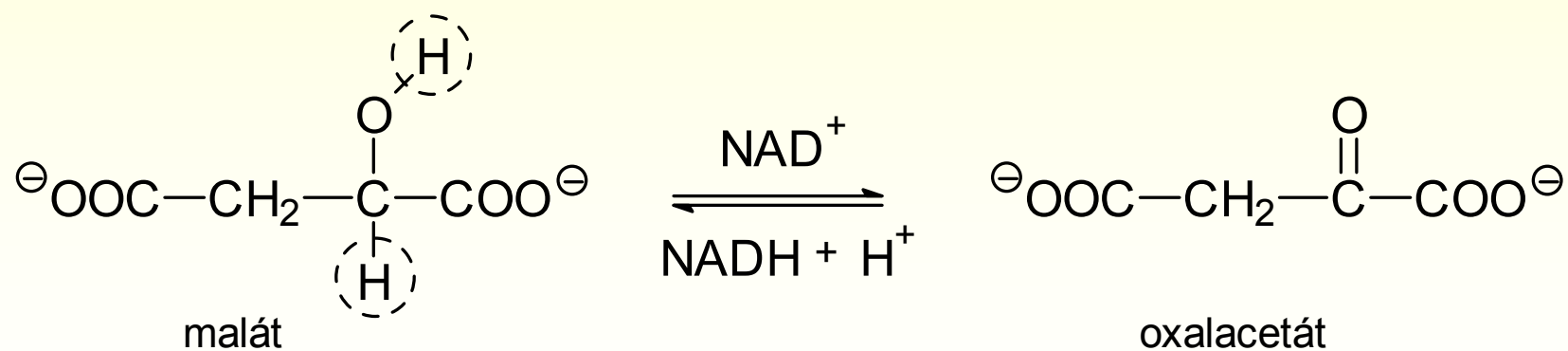
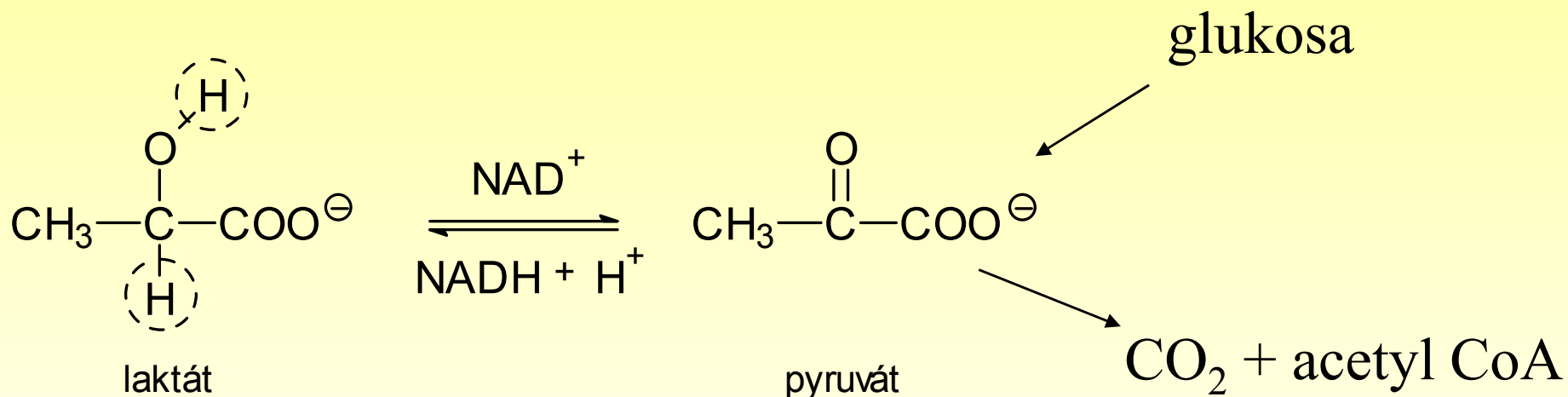


kys. oxaloctová

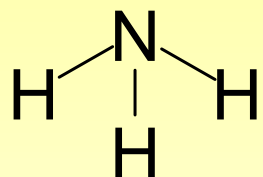


kys. 2-oxoglutarová

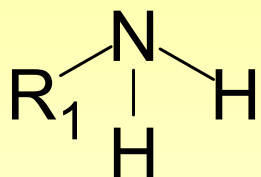
Přeměny hydroxykyselin a oxokyselin



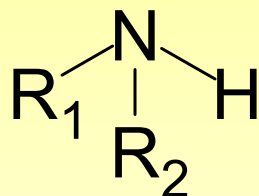
Aminy



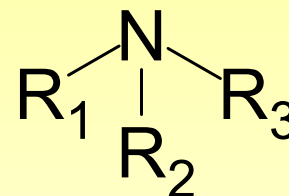
amoniak



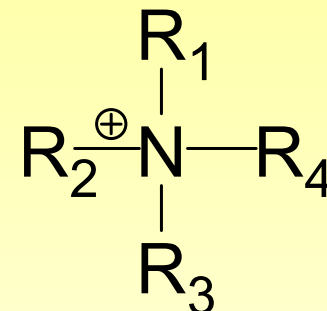
primární
amin



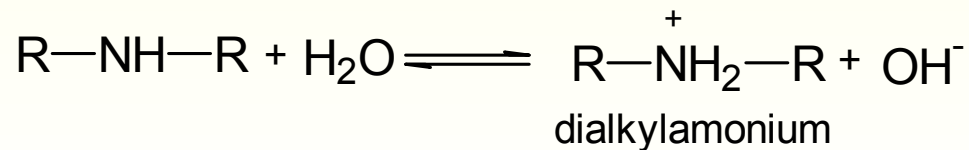
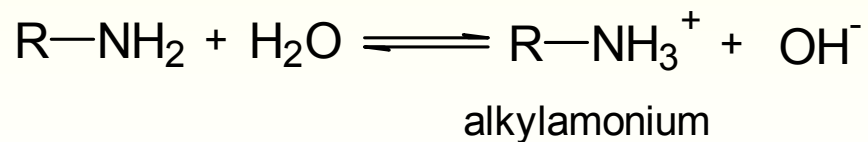
sekundární
amin



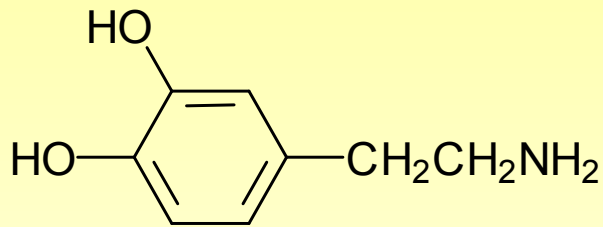
terciární
amin



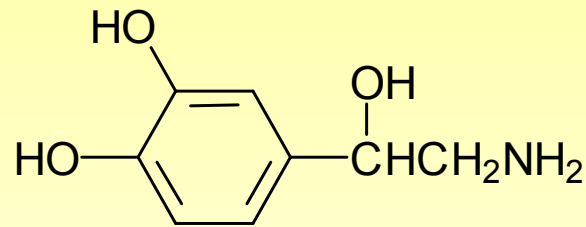
kvarterní
amonná sůl



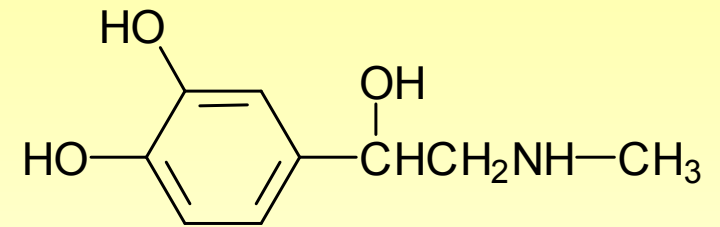
Biogenní aminy



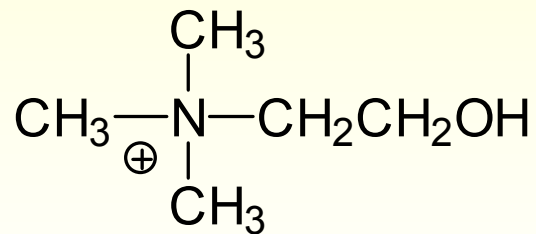
dopamin



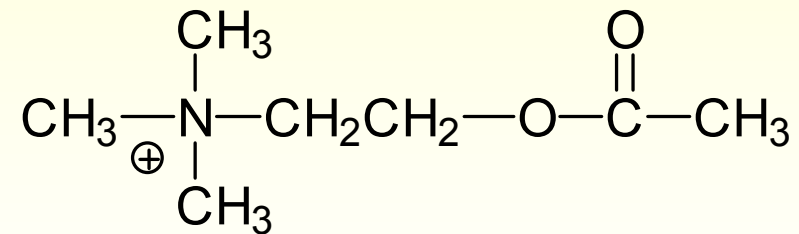
noradrenalin



adrenalin

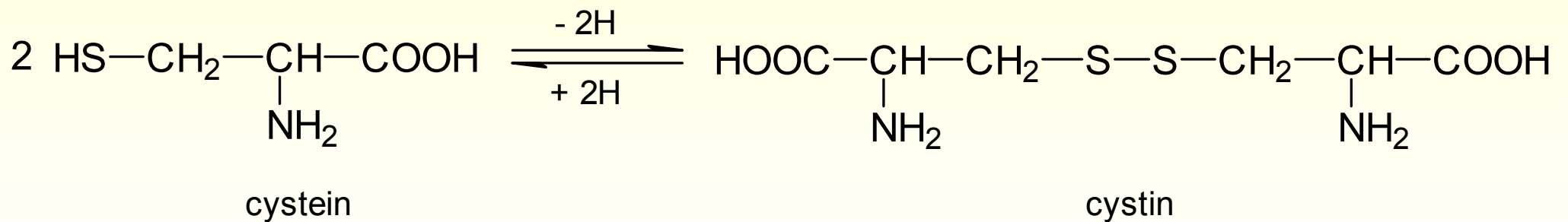
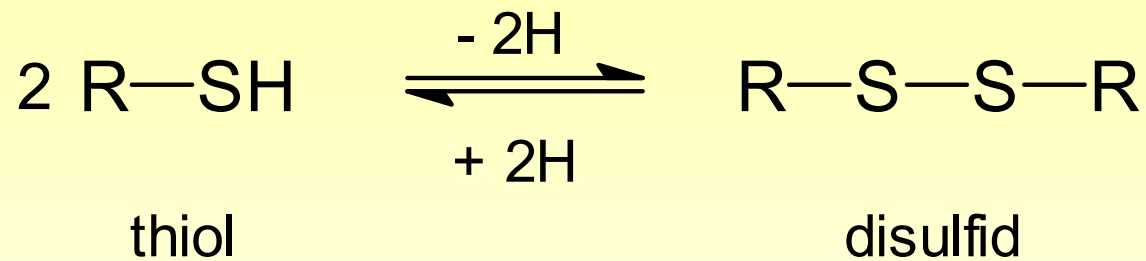


cholin



acetylcholin

Thioly

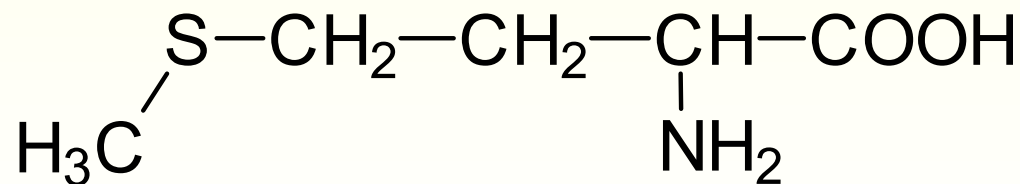
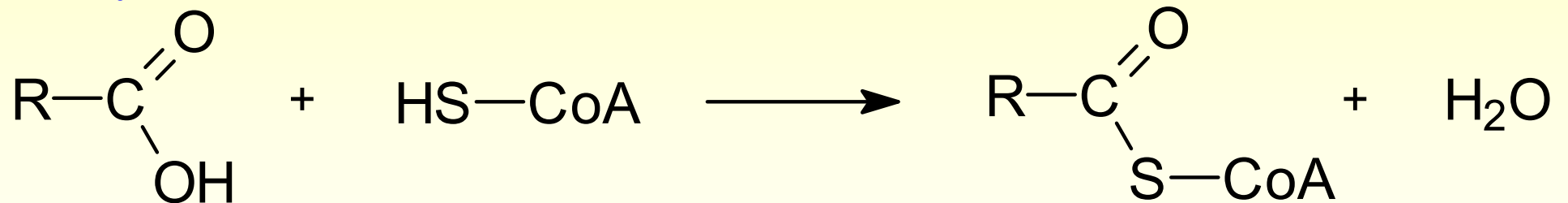


Významné thioly

glutathioperoxidasa

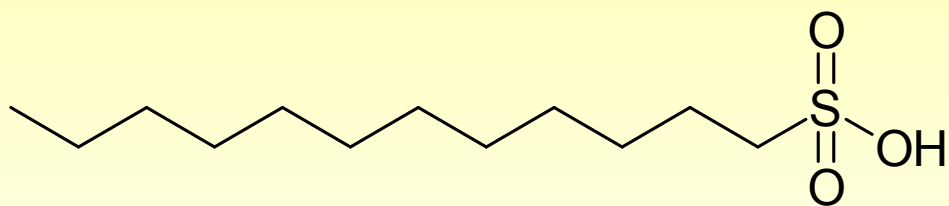


Koenzym A:

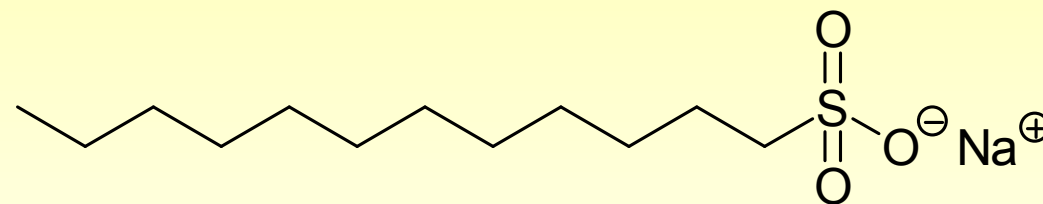


methionin

Sulfonové kyseliny



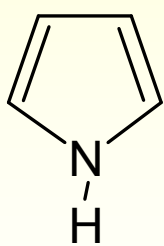
dodekansulfonová kyselina



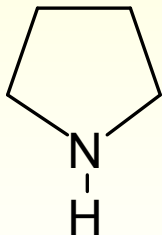
natrium-dodekansulfonát

Heterocyklické sloučeniny

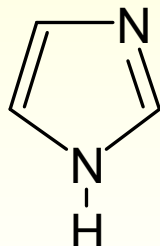
- Cyklické sloučeniny s jiným atomem než C v kruhu
- Nejstabilnější 5ti a 6ti členné heterocykly
- Přednost mají triviální názvy



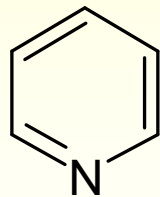
pyrrol



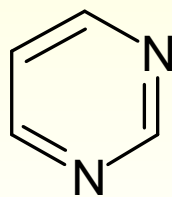
pyrrolidin



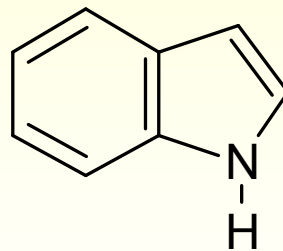
imidazol



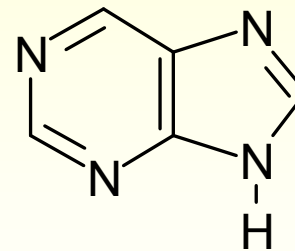
pyridin



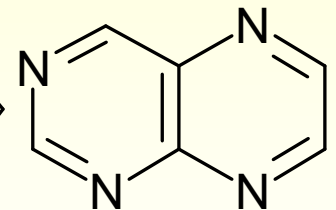
pyrimidin



indol

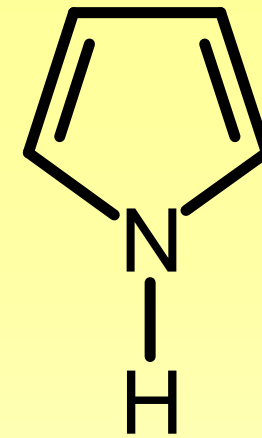


purin

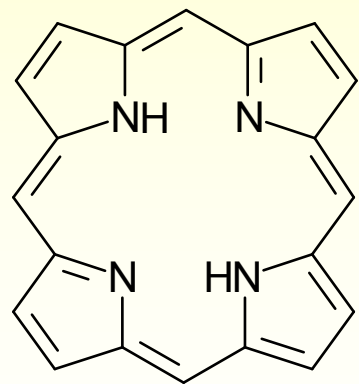


pteridin

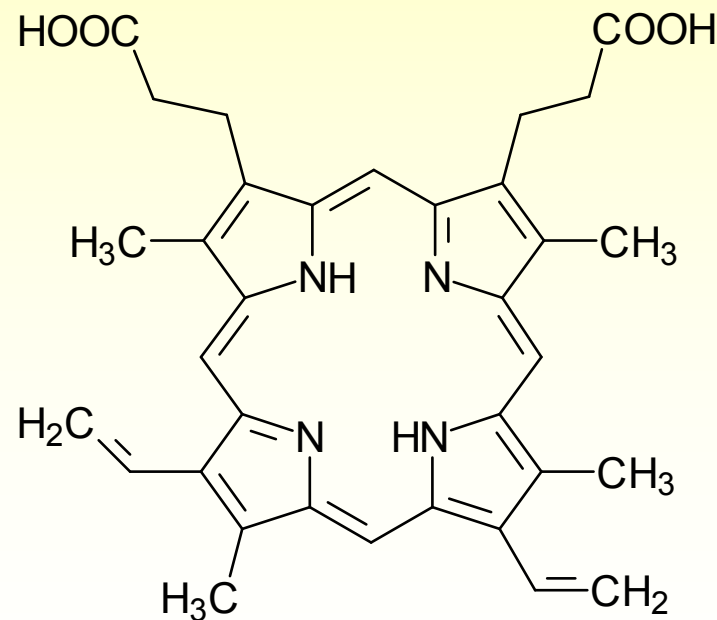
Pyrrol



- Cyklické tetrapyrroly (př. hem, kyanokobalamin)



porfin

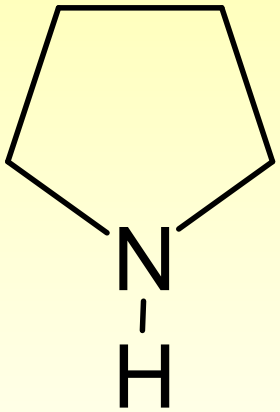


protoporfyryn IX

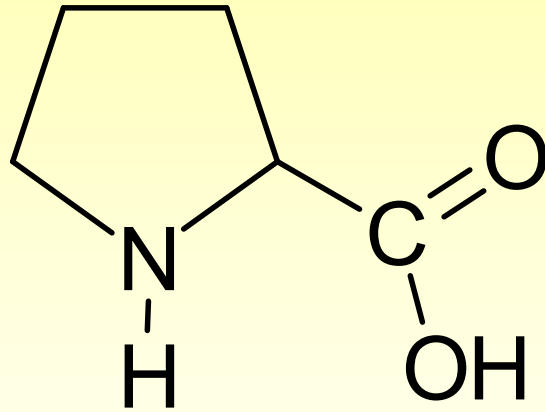
Hem:

- hemoglobin
- myoglobin
- cytochromy
- katalasa

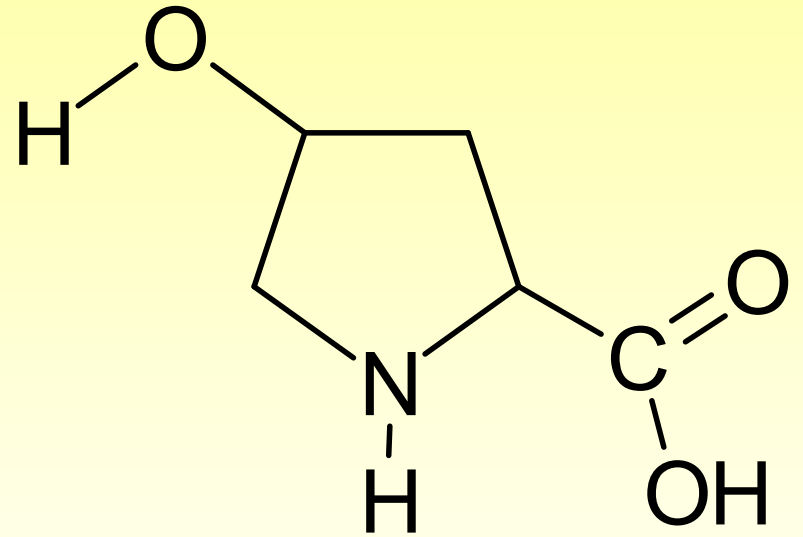
Pyrrolidin



pyrrolidin

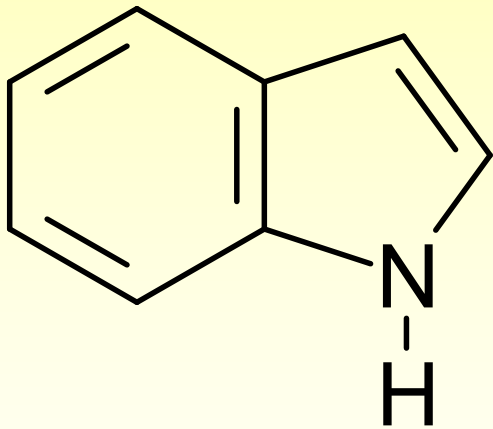


prolin

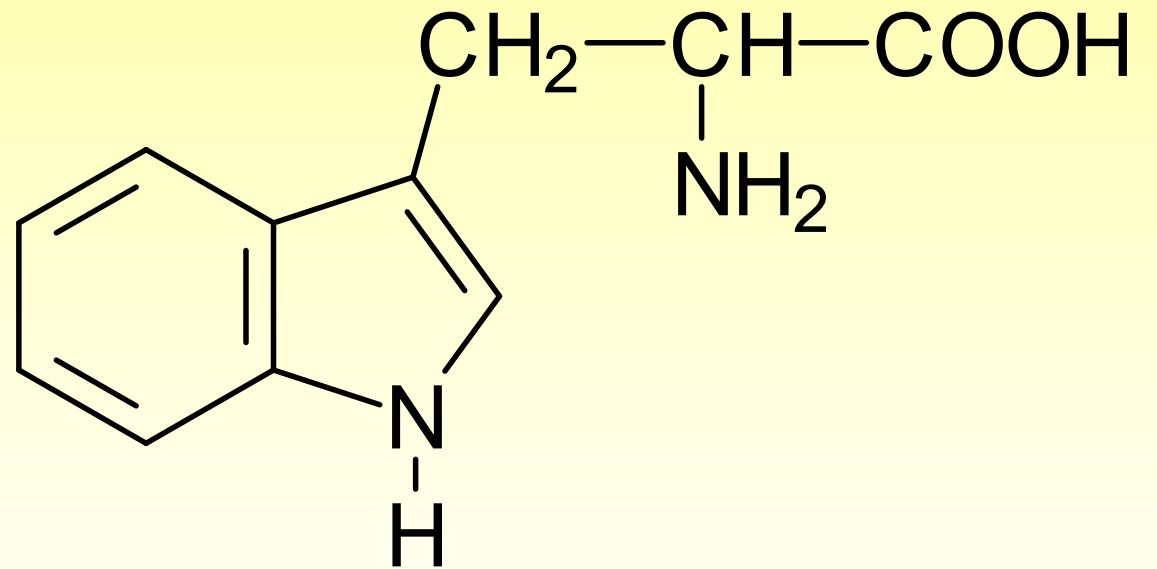


4-hydroxyprolin

Indol

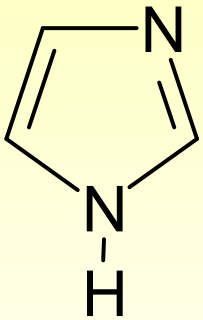


indol

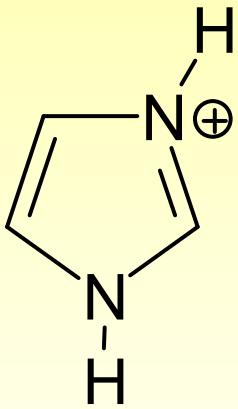


tryptofan

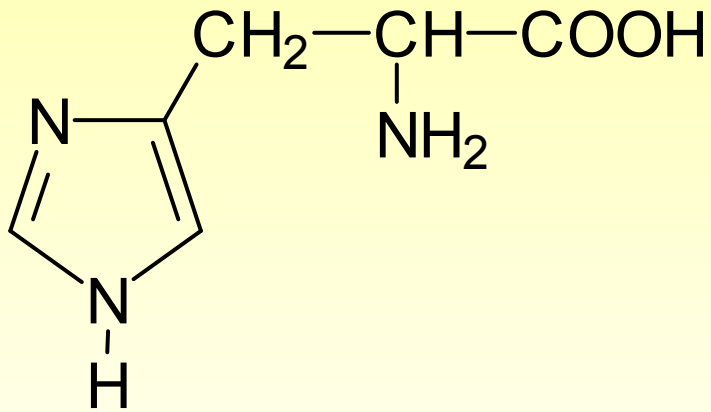
Imidazol



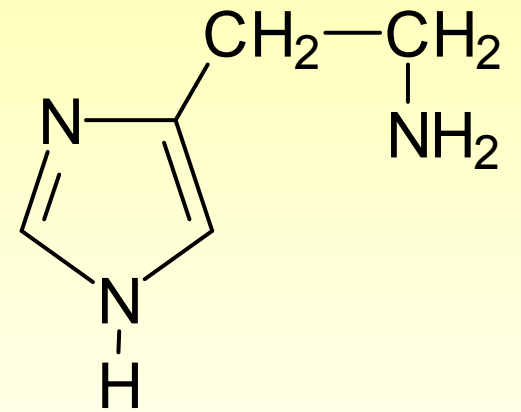
imidazol



imidazolium

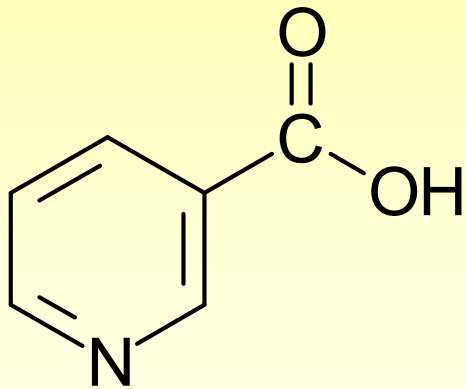


histidin

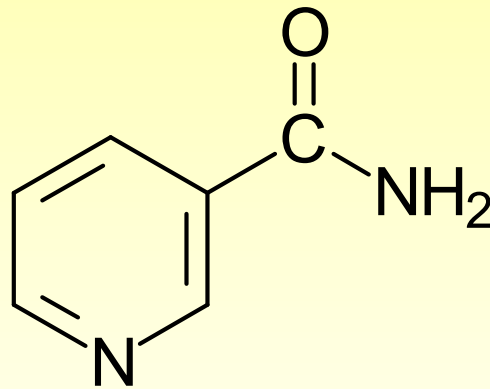


histamin

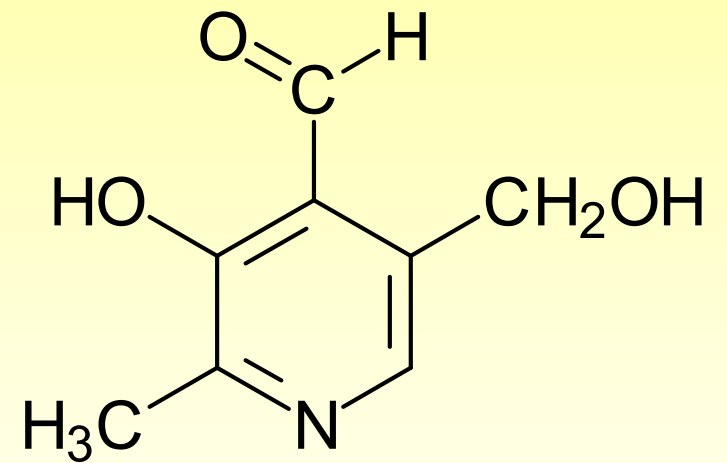
Pyridin



nikotinová kyselina



nikotinamid

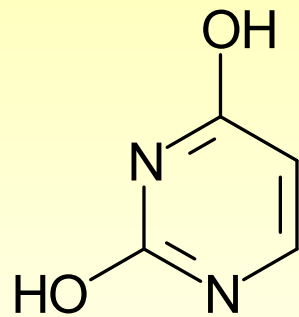


pyridoxal

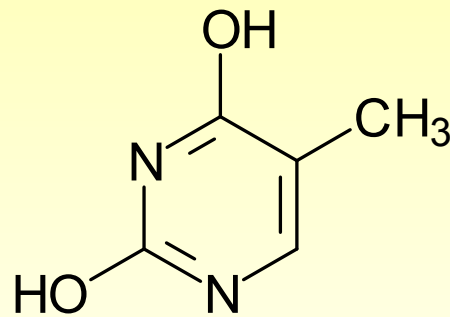
Pyrimidin



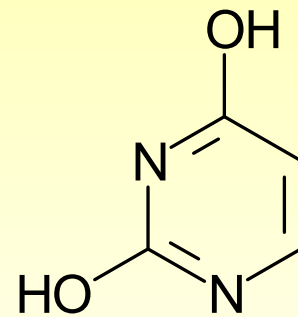
cytosin



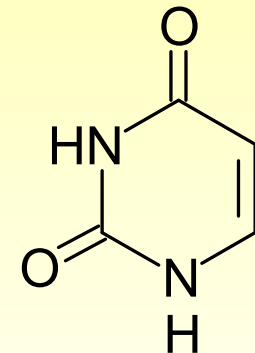
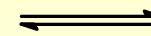
uracil



thymin



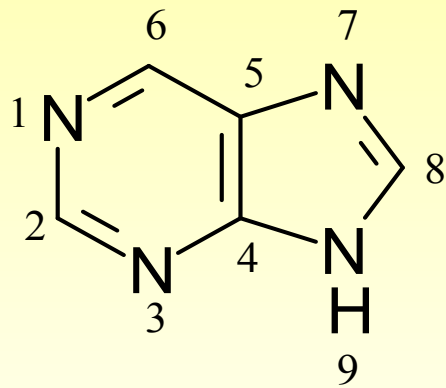
laktim uracilu



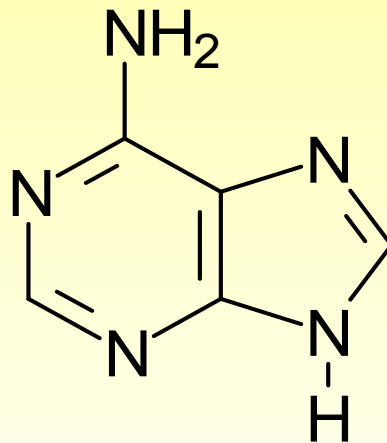
laktam uracilu

Pyrimidinové báze

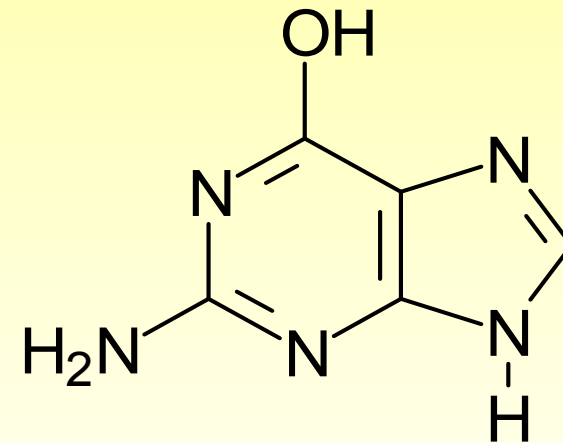
Purin



purin



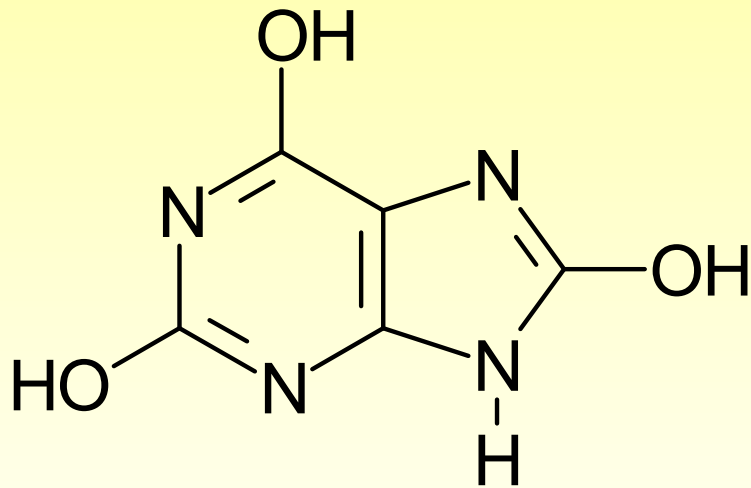
adenin



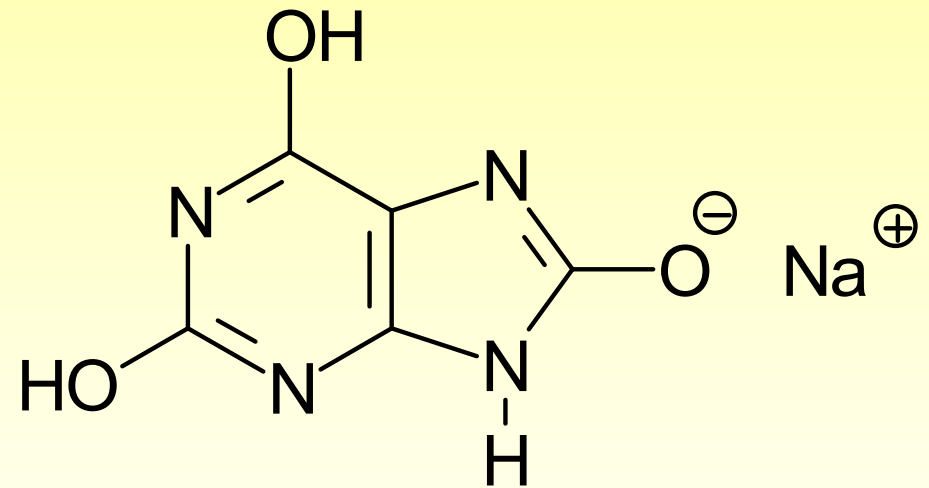
guanin

Purinové báze

Močová kyselina



močová kyselina



hydrogenurát sodný