

Inovace bakalářského studijního oboru Aplikovaná chemie

<http://aplchem.upol.cz>

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Tento projekt je spolufinancován
Evropským sociálním fondem a státním
rozpočtem České republiky.



evropský
sociální
fond v ČR



EVROPSKÁ UNIE



MINISTERSTVO ŠKOLSTVÍ,
MLÁDEŽE A TĚLOVÝCHOVY



OP Vzdělávání
pro konkurenceschopnost

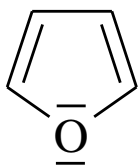


OKRESNÍ HOSPODÁŘSKÁ
KOMORA OLOMOUČ

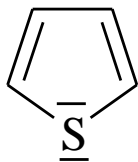
INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ

Heterocyklické sloučeniny

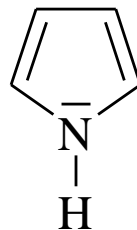
Pětičlenné heterocykly



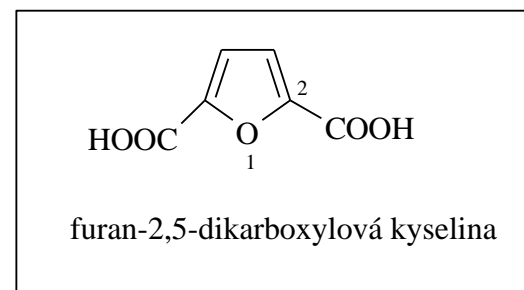
furan



thiofen



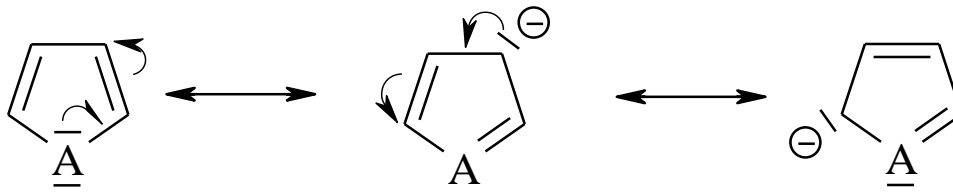
pyrrol



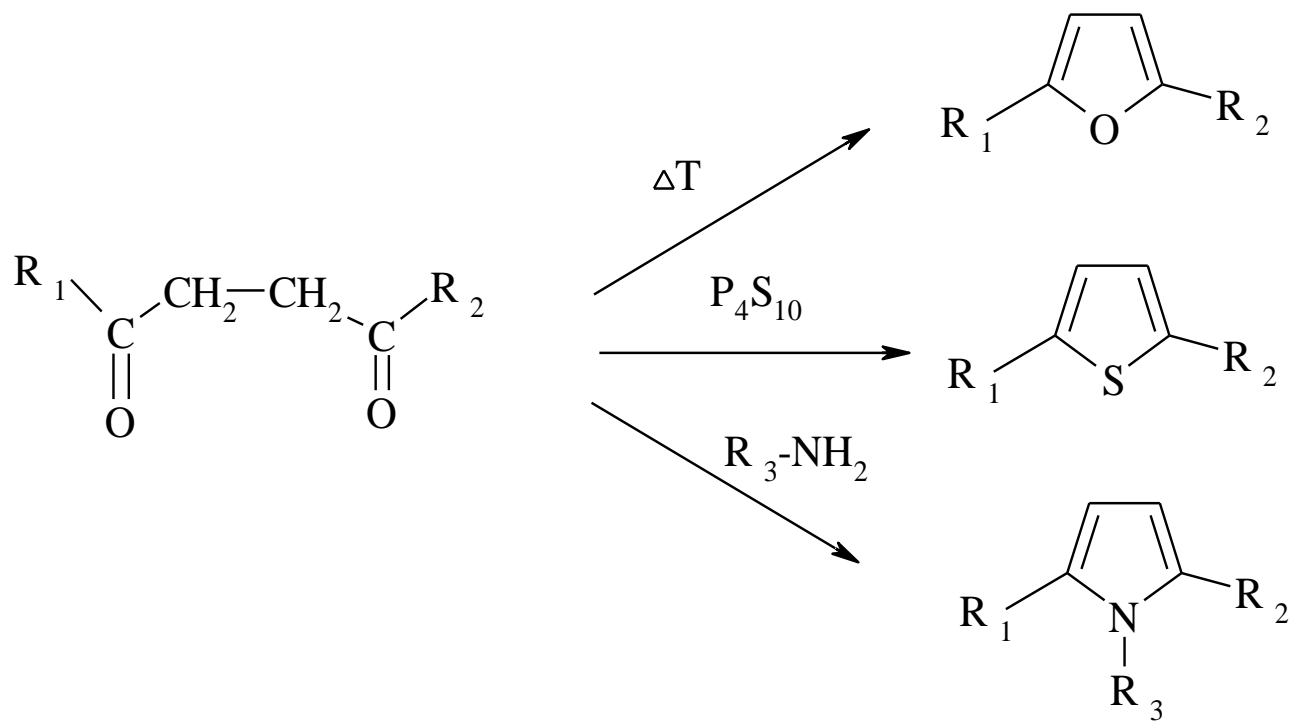
Aromatický charakter – splňují Hückelovo pravidlo (1. systém planární 2. Cyklický a plně konjugovatelný 3. $4n + 2\pi e$)

Aromaticita: thiofen > pyrrol > furan

Reaktivita: S_E

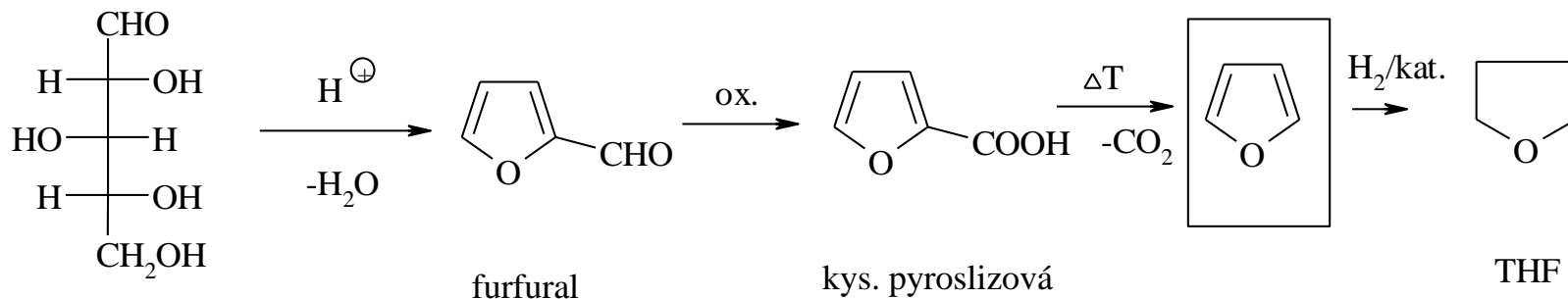


Obecná příprava:

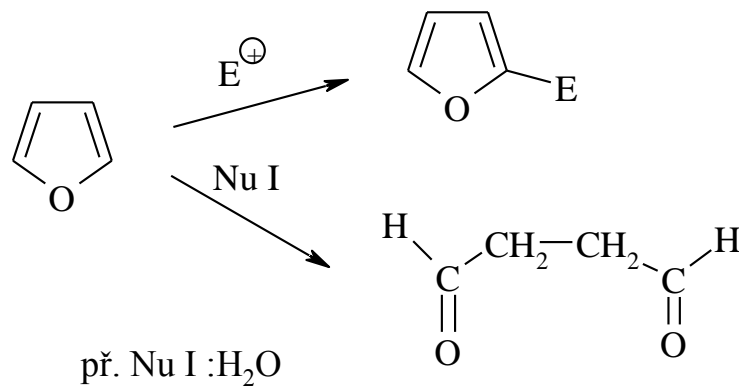


Furan

Průmyslová výroba:

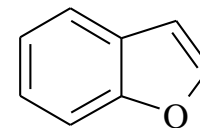
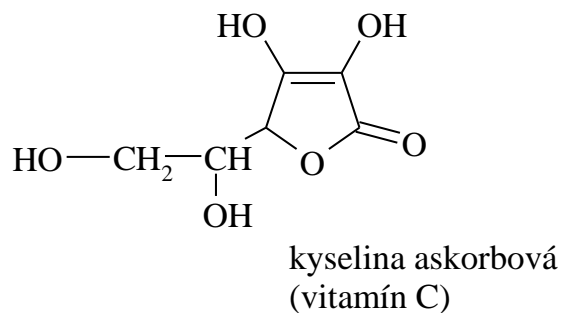


Reaktivita:



Nízká aromaticita → snadné otevírání furanového cyklu

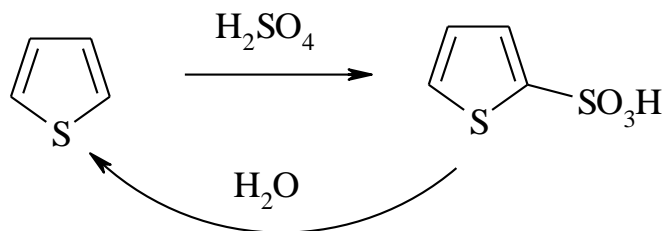
Zástupci:



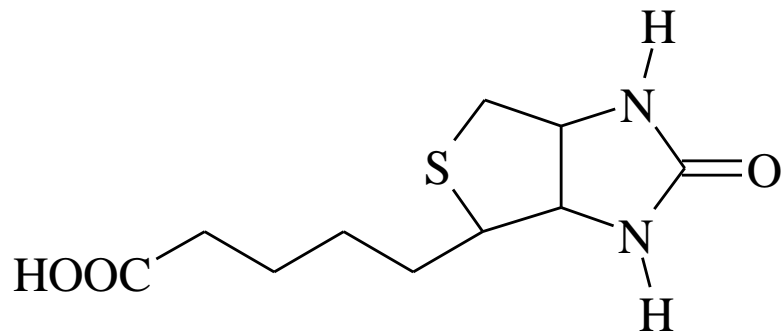
kumaron
(benzofuran)

Thiofen

Zdroj: černouhelný dehet



Thiofen – nejaromatictější (nejstabilnější)

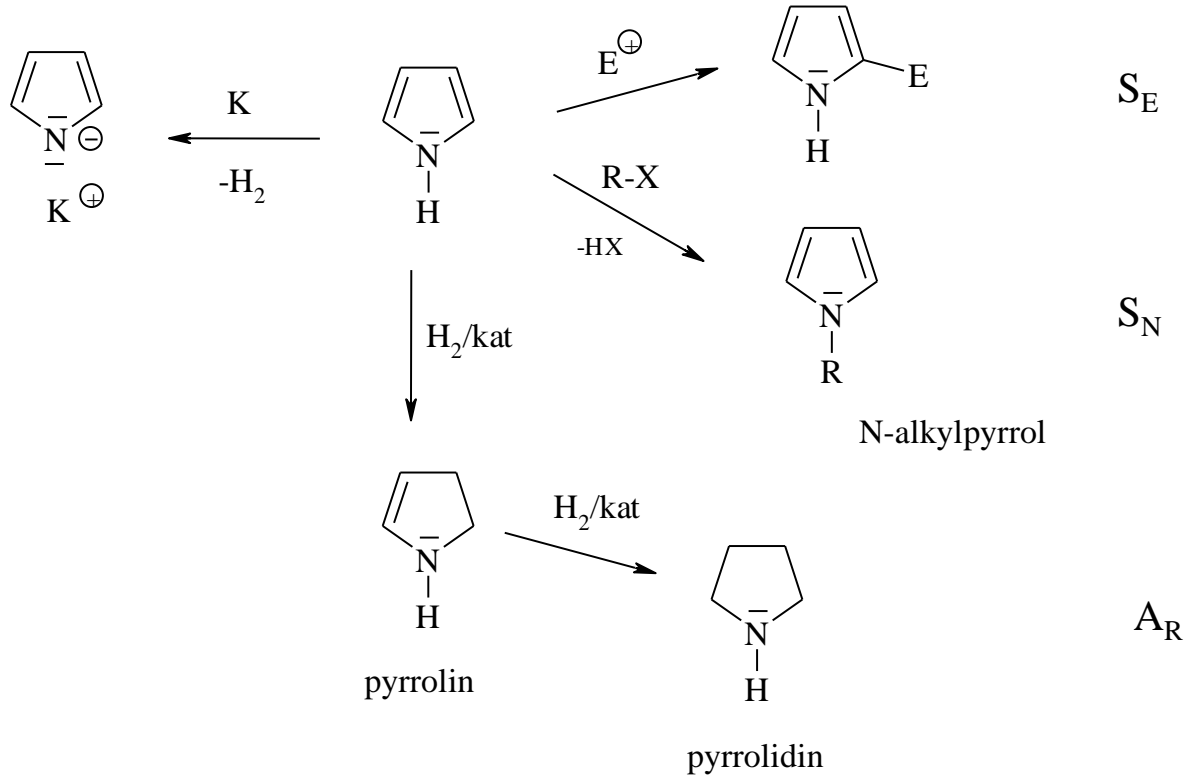


biotin
(vitamín H)

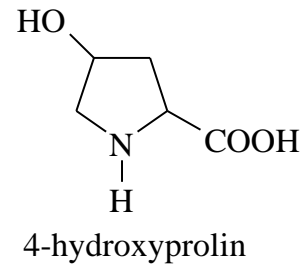
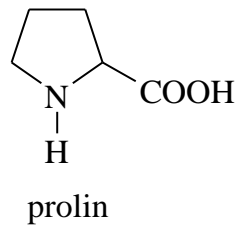
Pyrrrol

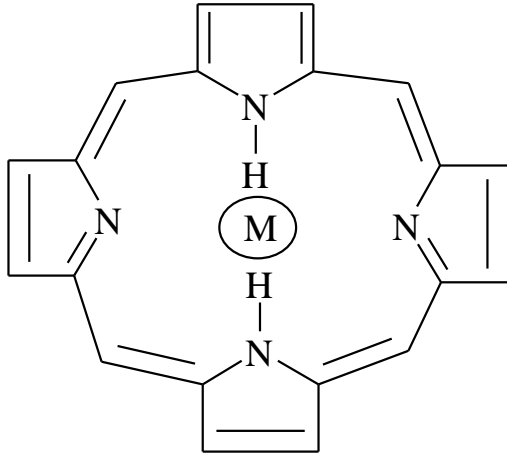
Zdroj: černouhelný dehet

Reaktivita:



zástupci

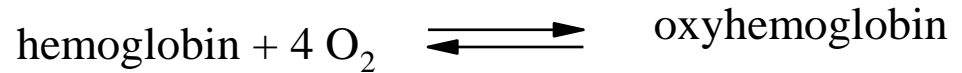




porfin

* **M = železo** → hem

hem + globin (bílkovina) = hemoglobin (červené krevní barvivo)



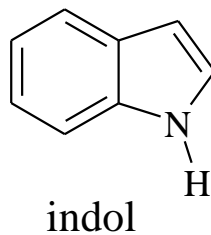
Žlučová barviva (rozkladné produkty hemu v játrech): bilirubin, biliverdin → urobilin (hnědá barva)

* **M = měď** → hemokyanin (měkkýši, koryši)

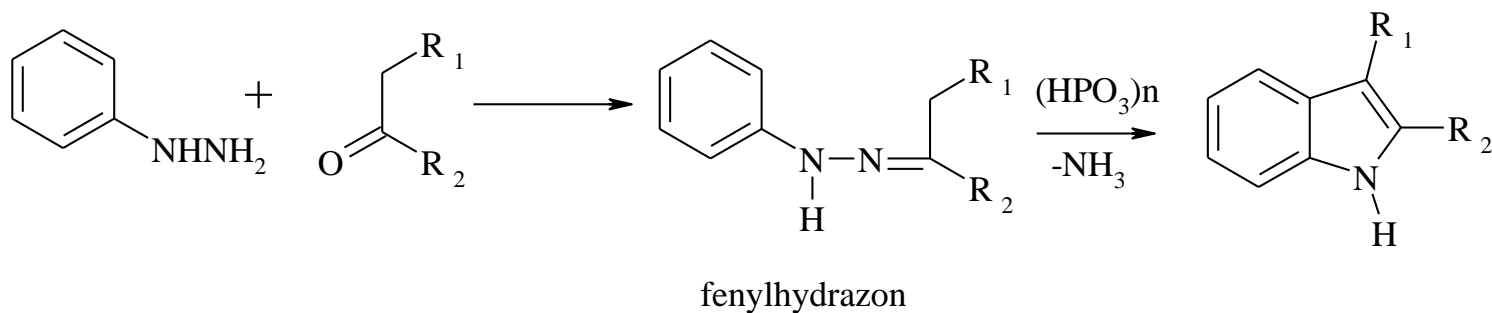
* **M = hořčík** → chlorofyl (zelené barvivo)

* **M = kobalt** → základ vitamínu B₁₂

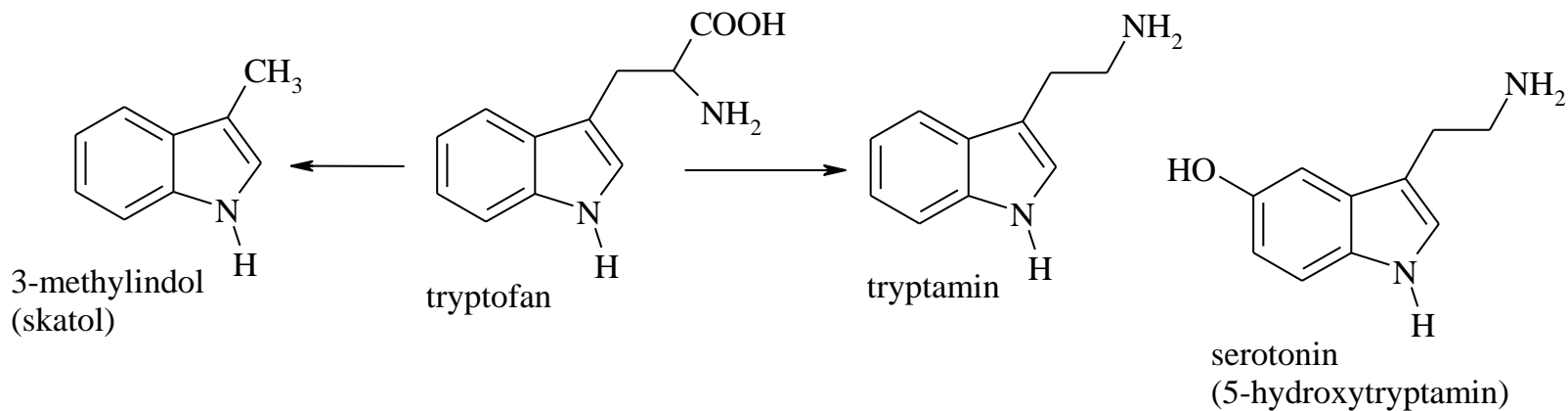
Zástupce kondenzovaného derivátu pyrrolu:



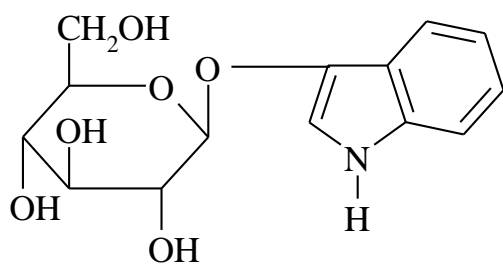
Příprava: Fisherova syntéza



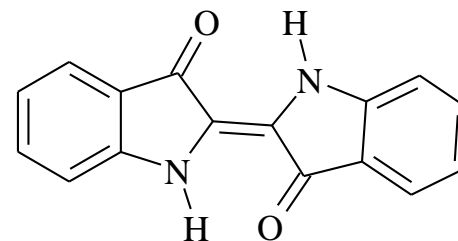
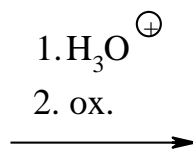
Zástupci:



Indigo – modré barvivo

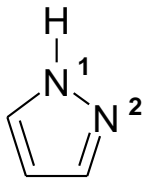


indikan

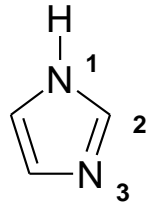


indigo

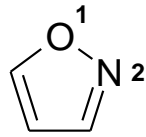
Pětičlenné heterocykly s více heteroatomy



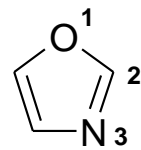
pyrazol



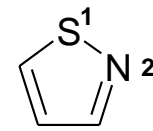
imidazol



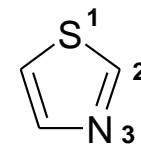
isoxazol



oxazol

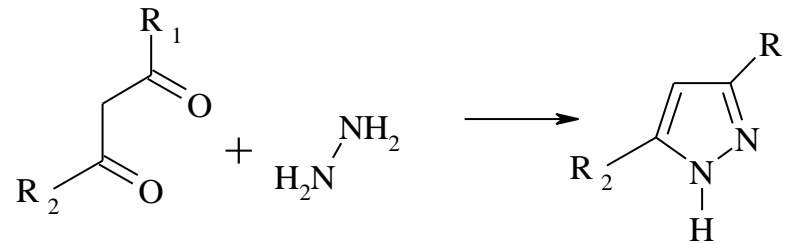


isothiazol

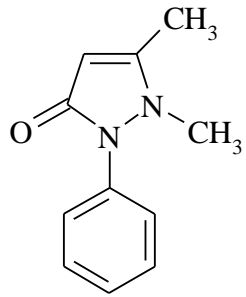


thiazol

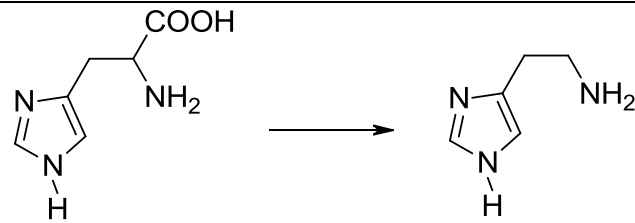
Příprava pyrazolu:



Zástupci:

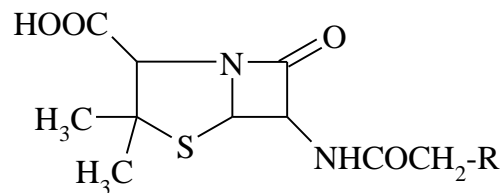


antipyrin

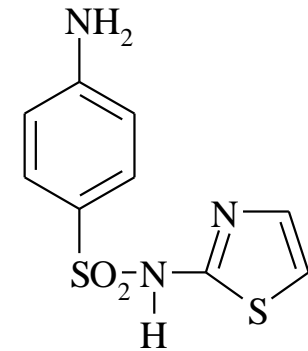


histidin

histamin

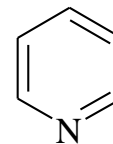


penicilín



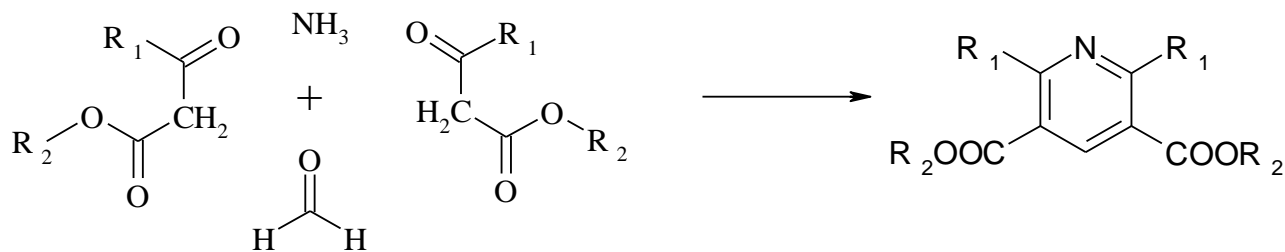
sulfathizol

Šestičlenné heterocykly

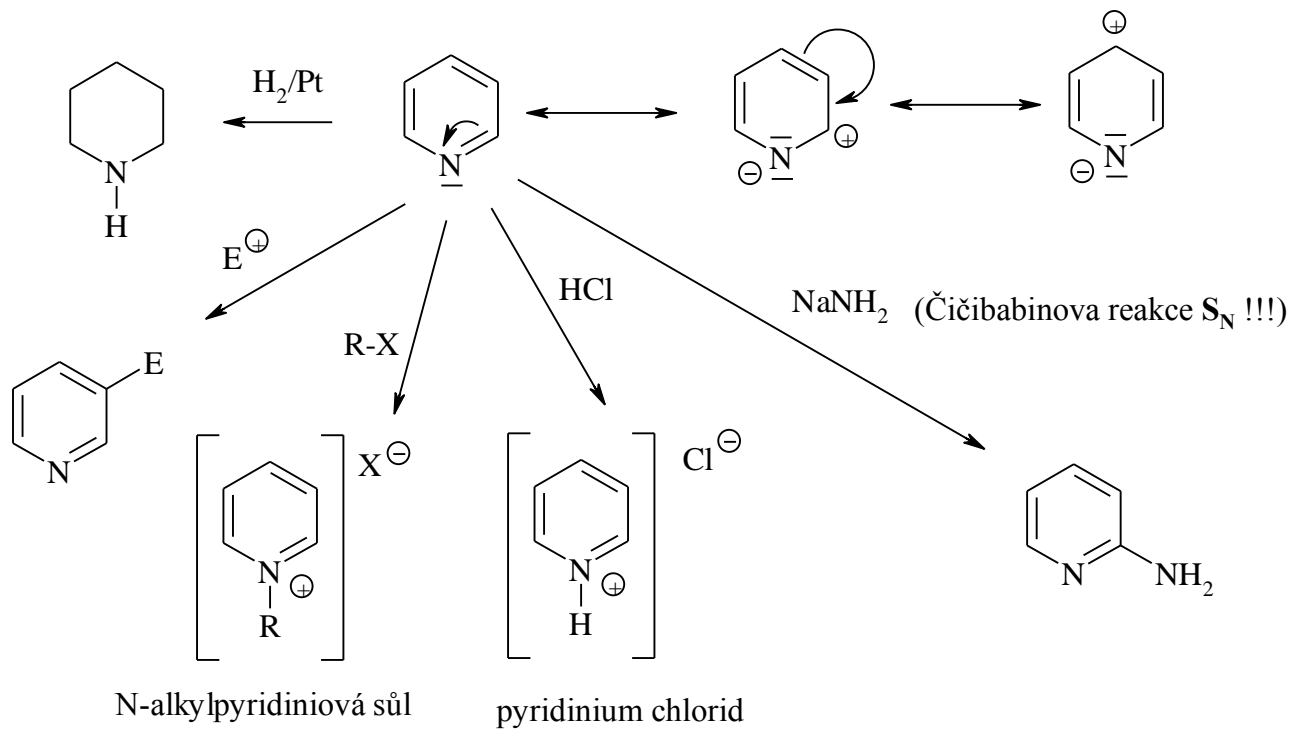


pyridin

Příprava: Hantzschova syntéza



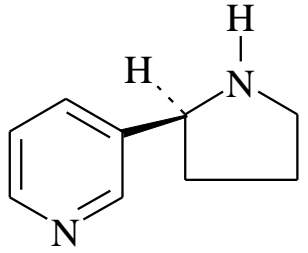
Reaktivita:



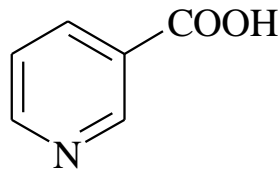
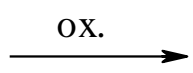
N-alkylpyridiniová sůl

pyridinium chlorid

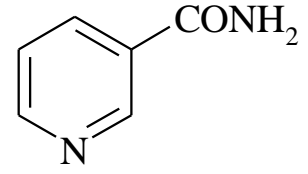
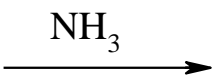
zástupci



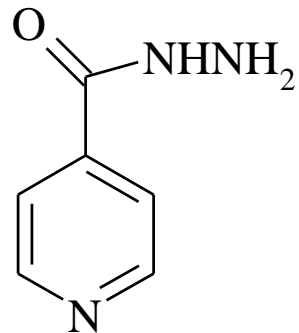
nikotin



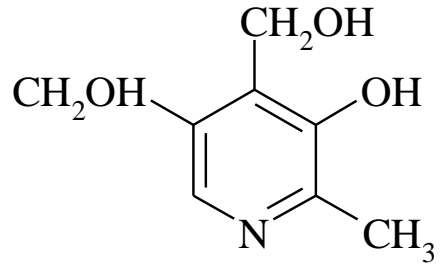
kyselina nikotinová



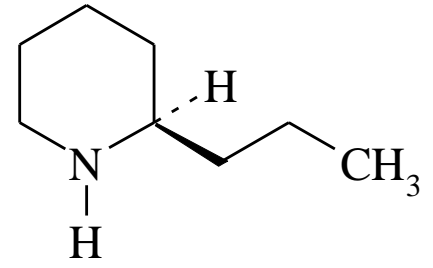
nikotinamid
(vitamin PP, niacin)



isoniazid

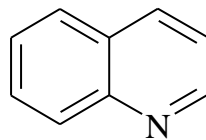


pyridoxin
(vitamin B6)

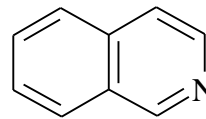


koniin

Zástupce kondenzovaného derivátu pyridinu

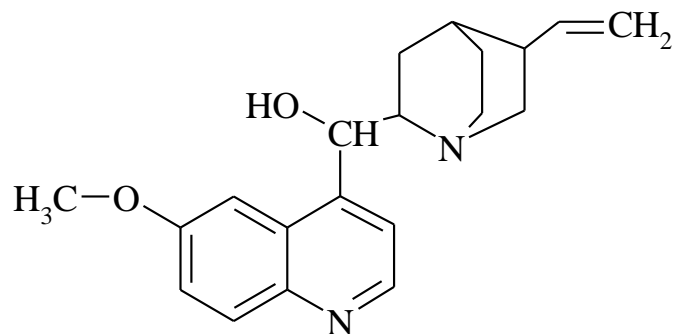
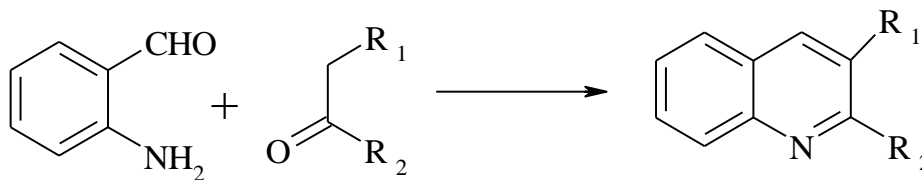


chinolin

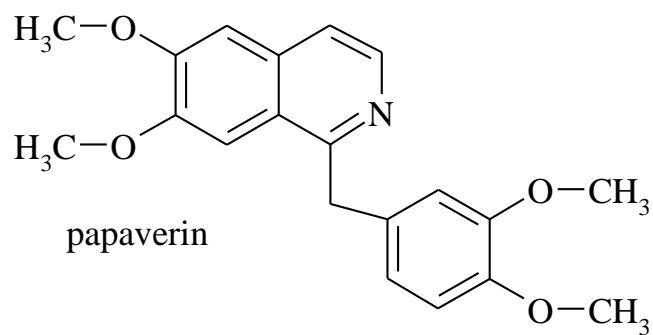


isochinolin

Příprava:

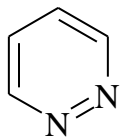


chinin

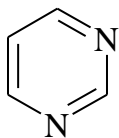


papaverin

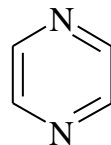
Šestičlenné heterocykly s více heteroatomy



pyridazin

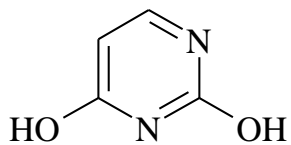


pyrimidin

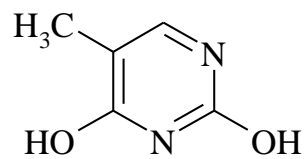
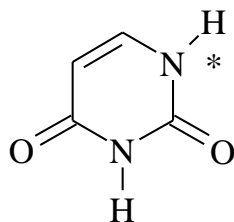
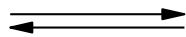


pyrazin

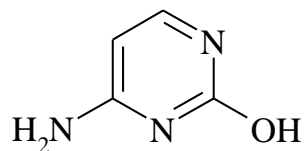
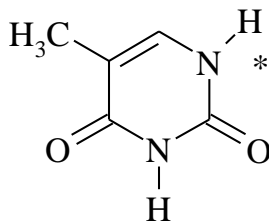
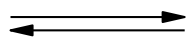
Pyrimidinové nukleobáze:



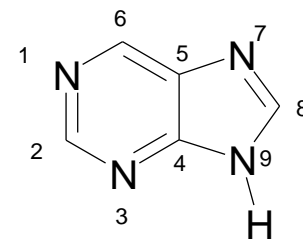
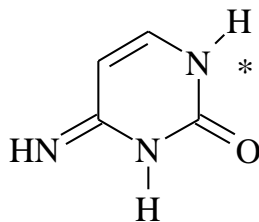
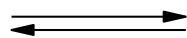
uracil (Ura)



thymin (Thy)

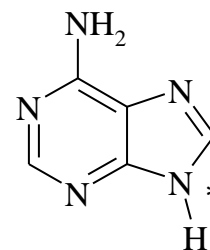


cytosin (Cyt)

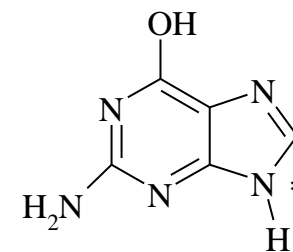


purin

Purinové nukleobáze

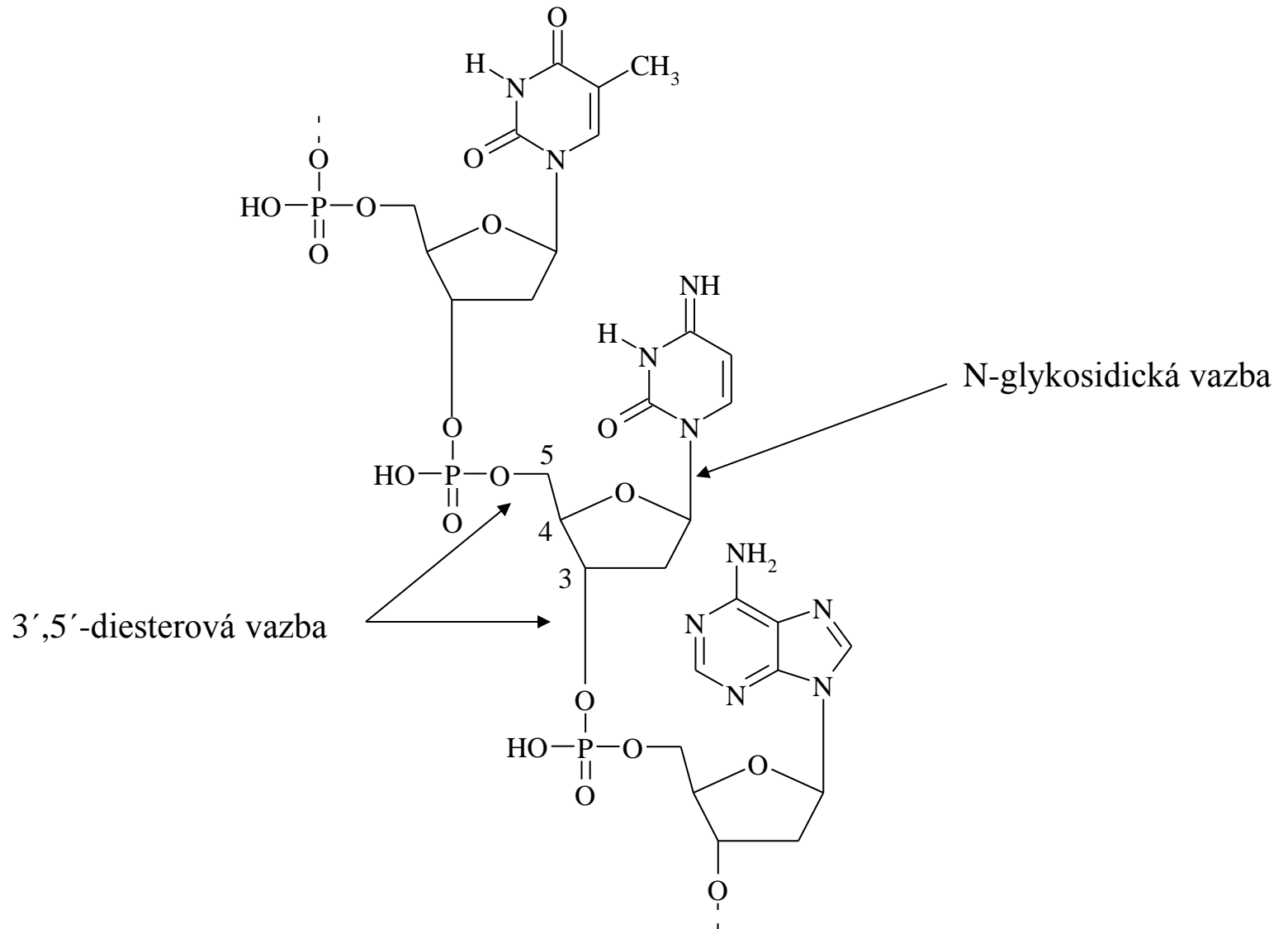


adenin (Ade)



guanin (Gua)

Znázornění sekvence T-C-A v DNA



Seminární úkoly:

1. Srovnejte bazické vlastnosti těchto dusíkatých heterocyklických sloučenin: pyrrol, pyrrolin (2,3-dihydropyrrol, pyrrolidin (2,3,4,5-tetrahydropyrrol)
2. Srovnejte bazicitu pyrrolu a pyridinu. A vysvětlete.
3. Odhadněte a pokuste se vysvětlit, který atom dusíku v a) pyrazolu b) imidazolu se bude snadněji protonizovat v prostředí kyselin.
4. Který z heterocyklů bude snadněji podléhat aromatické elektrofilní substituci - pyridin nebo pyrrol? Co vznikne jejich nitrací? A vysvětlete
5. Sloučeniny obsahující furanový cyklus jsou náchylnější ke štěpení (otevírání) cyklu, než analogické sloučeniny obsahující thiofenový cyklus. Vysvětlete
6. Pomocí Hantzschovy syntézy navrhnete syntézu pyridinu, který bude obsahovat v poloze 2 a 6 propylové skupiny.
7. Určete absolutní konfiguraci na chirálních centrech v a) nikotinu b) koniinu
8. Nakreslete strukturu těchto nukleosidů a) adenosin b) thymidin
9. Nakreslete strukturu tohoto nukleotidu: thymidin-5'-fosfátu
10. Jaké je párování nukleobazi v a) DNA b) RNA
11. Znázorněte tuto sloučeninu: *N*-benzyl-9-methylpurin-6-amin