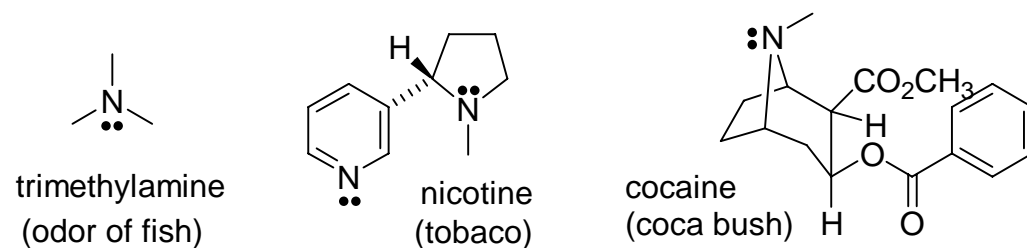


Chapter 12. Amines

Amines are composed of nitrogen atoms bearing alkyl or aromatic groups. The lone pair of electrons on the nitrogen makes amines basic and nucleophilic.



12.1 Naming Amines

Primary – RNH_2

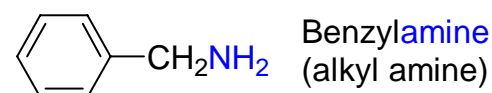
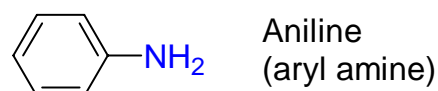
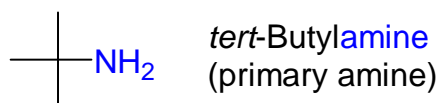
Secondary – R_2NH

Tertiary – R_3N

Quaternary ammonium salts – $\text{R}_4\text{N}^+ \text{X}^-$

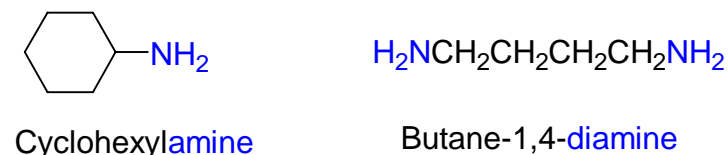
Alkylamines – alkyl-substituted amine

Arylamines – aryl-substituted amine

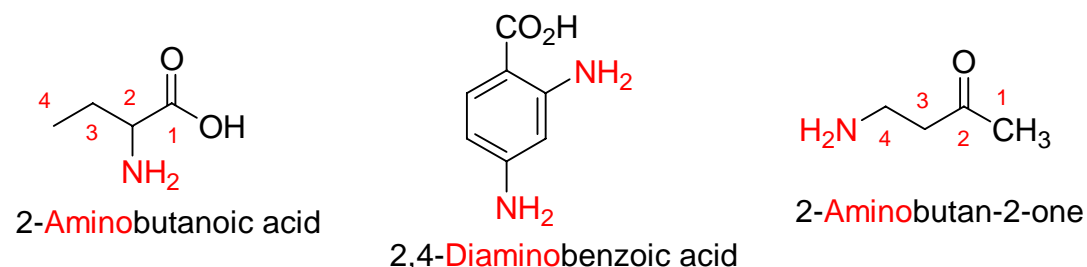


IUPAC system

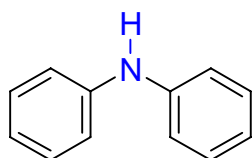
Primary amines (RNH_2) are named by adding the suffix **-amine** to the name of the organic substituent.



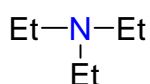
Amines that have additional functional groups are named by considering the NH_2 as an **amino** substituent on the parent molecule.



Symmetrical secondary and tertiary amines are named by adding the prefix **di-** or **tri-** to the alkyl group.

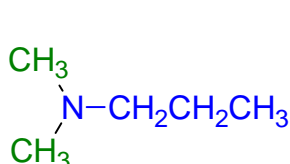


Diphenylamine

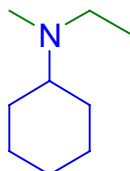


Triethylamine

Unsymmetrically substituted secondary and tertiary amines are named as **N-substituted primary amines** (the largest organic group is chosen as the parent).



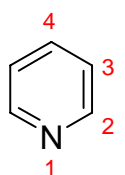
N,N-Dimethylpropylamine



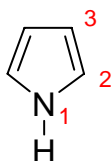
N-Ethyl-*N*-methylcyclohexylamine

Heterocyclic amines – compounds in which the nitrogen atom occurs as part of a ring

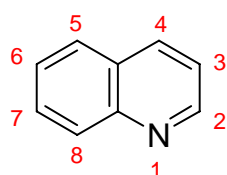
Each one has its own parent name and the nitrogen atom is numbered as position 1.



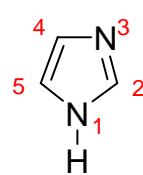
Pyridine



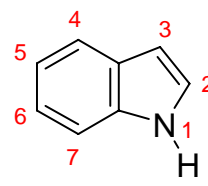
Pyrrole



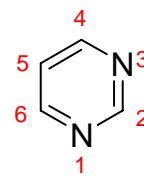
Quinoline



Imidazole

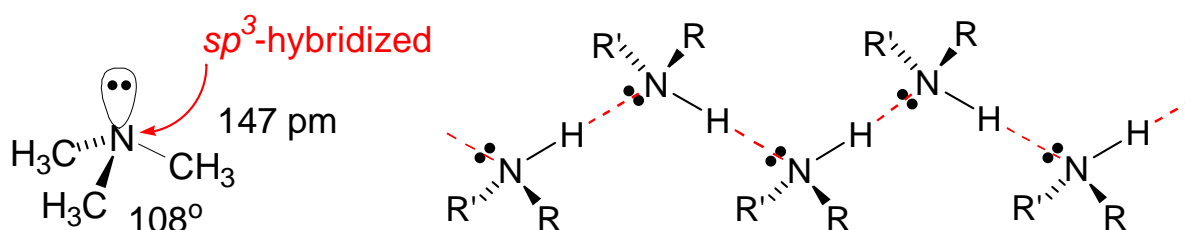


Indole



Pyrimidine

12.2 Structure and Properties of Amines



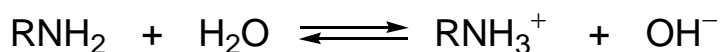
Amines are highly polar, and those with fewer than five carbon atoms are generally water-soluble. Primary and secondary amines form hydrogen bonds and therefore have higher boiling points than alkanes of similar molecular weight.

Low-molecular-weight amines have a distinctive fishlike aroma.

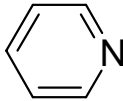
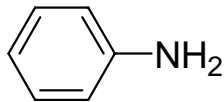
12.3 Basicity of Amines

Because of the lone pair electrons on nitrogen, amines are both basic and nucleophilic.

The relative order of base strength, pK_b .



$$K_b = \frac{[\text{RNH}_3^+][\text{OH}^-]}{[\text{RNH}_2]} \quad pK_b = -\log k_b$$

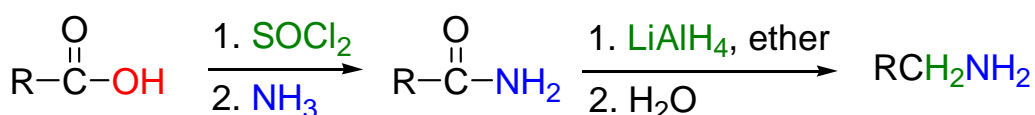
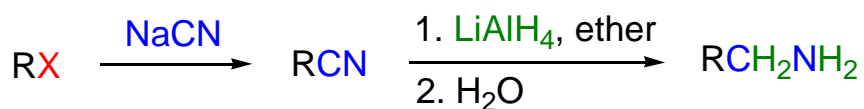
Amines	pK_b		
$(\text{CH}_3\text{CH}_2)_3\text{N}$	2.99		
$\text{CH}_3\text{CH}_2\text{NH}_2$	3.19		8.75
$(\text{CH}_3)_2\text{NH}$	3.27		
CH_3NH_2	3.34		9.37
$(\text{CH}_3\text{CH}_2)_2\text{NH}$	3.51		
$(\text{CH}_3)_3\text{N}$	4.19		
NH_3	4.74		

Arylamines are **weaker base** than alkylamines by a factor of about 10^6 . The nitrogen lone-pair electrons in an arylamine are shared by orbital overlap with the π orbitals of the aromatic ring.

Amides (RCONH_2) are **nonbasic**. Amides don't react with acids. The nitrogen lone-pair electrons are shared by orbital overlap with the neighboring carbonyl-group π orbital.

12.4 Synthesis of Amines

Reduction of Nitriles and Amides



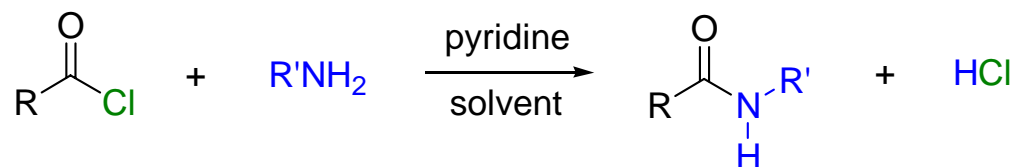
S_N2 Alkylation Reaction of Alkyl Halides

Reaction of ammonia or an alkylamine with an alkyl halide.

12.5 Reactions of Amines

Alkylation and acylation are two most important reactions of alkylamines.

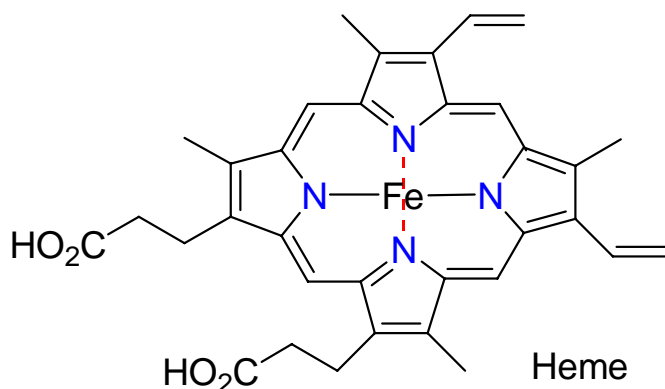
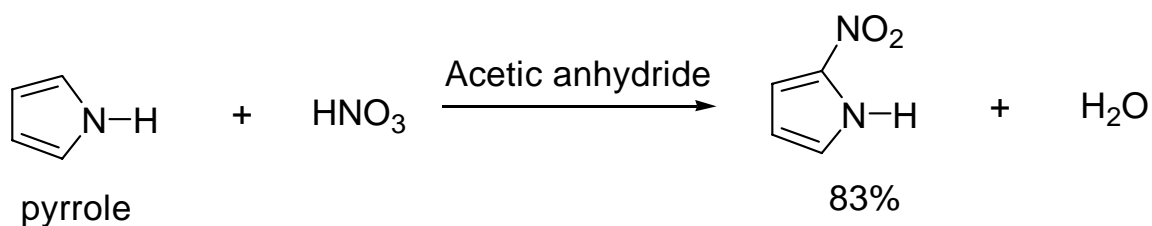
Primary and secondary (but not tertiary) amines can be acylated with acid chlorides or acid anhydrides.



12.6 Heterocyclic Amines

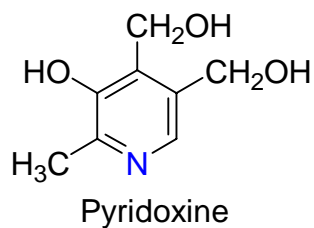
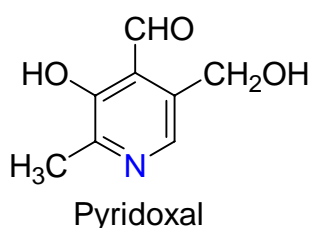
Heterocycles contain one or more hetero (different) atoms in addition to carbon in their ring.

Pyrrole, a Five-Membered Aromatic Heterocycle

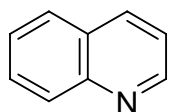


Pyridine, a Six-Membered Aromatic Heterocycle

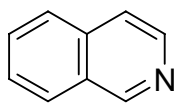
The B₆ complex vitamins pyridoxal and pyridoxine (for synthesis of some amino acids)



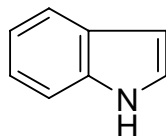
Fused-Ring Aromatic Heterocycles



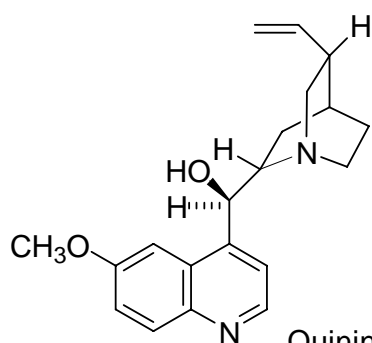
Quinoline



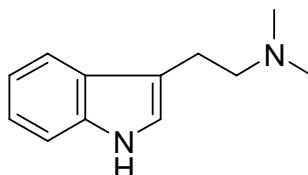
Isoquinoline



Indole



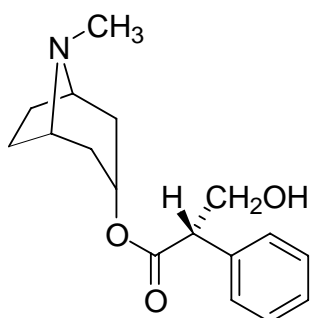
Quinine (antimalarial drug)



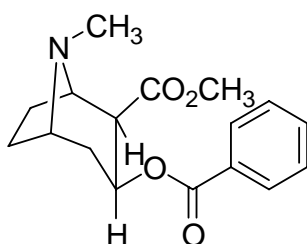
N,N-Dimethyltryptamine (hallucinogen)

12.7 Alkaloids: Naturally Occurring Amines

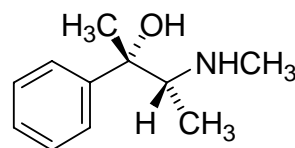
Alkaloids – Their aqueous solutions are slightly basic.



Atropine (antispasmodic for colitis)

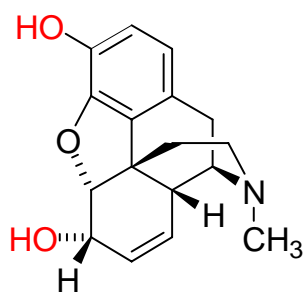


Cocaine (anesthetic, central nervous system stimulant)

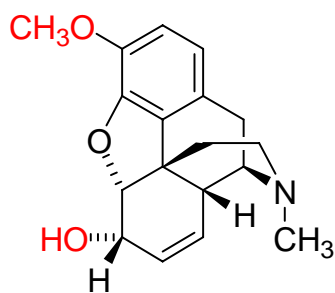


Ephedrin
(bronchodilator and decongestant)

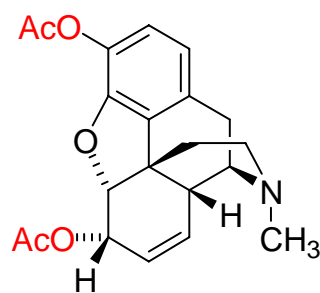
Opium and Opiates



Morphine



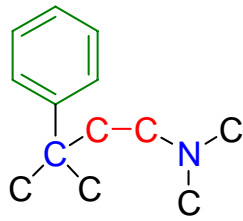
Codeine



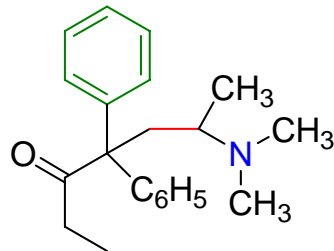
Heroin

The morphine rule:

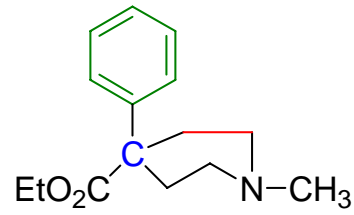
Biological activity requires (1) an aromatic ring, attached to (2) a quaternary carbon, attached to (3) two more carbons, attached to (4) a tertiary amine.



The morphine rule



Methadone



Meperidine