

24.1: NAMING AMINES

OBJECTIVES

After completing this section, you should be able to

1. classify a given amine as being primary, secondary or tertiary.
2. explain, briefly, the difference in meaning of the terms primary, secondary and tertiary when they are applied to the structures of amines and alcohols.
3. determine whether a given structure represents a quaternary ammonium cation.
4. provide an acceptable IUPAC name for an amine, given its Kekulé, condensed or shorthand structure.
5. draw the structure of an amine, given its IUPAC name.
6. give the name and structure of one typical heterocyclic amine (e.g., pyridine).

KEY TERMS

Make certain that you can define, and use in context, the key terms below.

- amine
- primary amine
- secondary amine
- quaternary ammonium cation
- tertiary amine

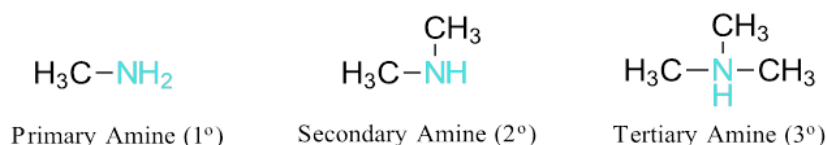
STUDY NOTES

You should recognize that heterocyclic amines—compounds in which the nitrogen atom occurs as part of a ring—are very common in organic chemistry. Be prepared to meet such compounds throughout this, and subsequent chapters, but do not try to memorize all of the names and structures given in the reading. You should, however, commit the structures of pyridine and pyrrole to memory.

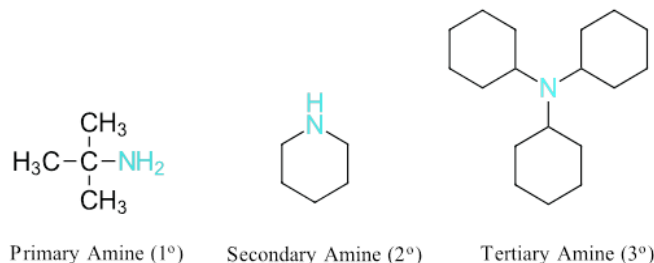
CLASSIFICATION OF AMINES

Amines are made up of an sp^3 hybridized nitrogen and are either alkyl substituted (alkylamines) or aryl substituted (aryl amines).

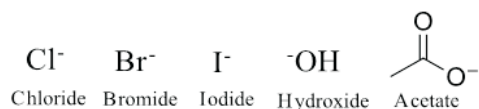
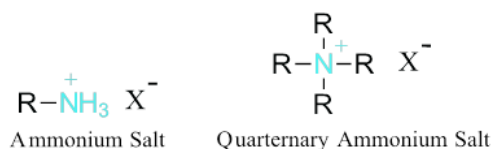
Amines are classified as primary, secondary, or tertiary based on the number of organic substituents directly attached to the nitrogen. An amine attached to one substituent is primary (1°), two substituents is secondary (2°), and three substituents is tertiary (3°).



EXAMPLE



Amines attached to 4 substituents and at least one substituent is a hydrogen are called ammonium salts. Amines attached to 4 alkyl substituents are called quaternary ammonium salts. The nitrogen in ammonium salts lacks lone pair electrons and carries a formal positive charge. Ammonium salts also require a negatively charged counter-ion which can vary in composition.

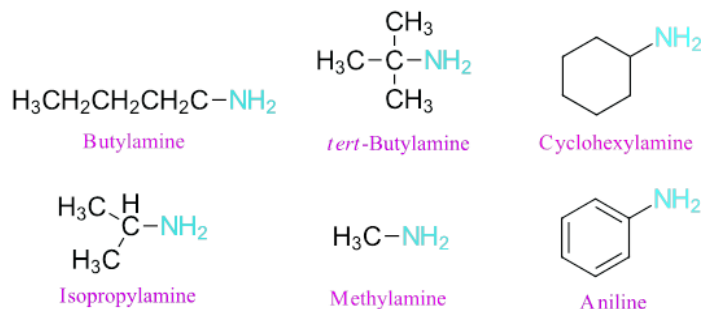


Common Counterions of Ammonium Salts

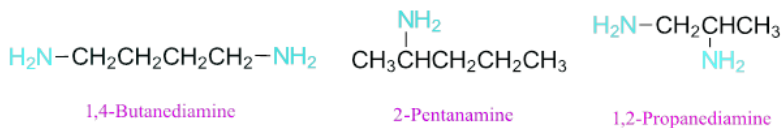
NOMENCLATURE OF AMINES

NOMENCLATURE OF PRIMARY AMINES

Primary amines are named in two main ways using the IUPAC system. They can either be named as alkylamines or as alkanamines. Most 1° amines which are attached to linear alkanes, cycloalkanes, and alkyl groups with common names (Section 3.3), tend to be named as alkylamines. The alkyl group is named as a substituent (**prefix + yl**) then the suffix -amine is added. Many amines have common names that are used by IUPAC, for example the primary arylamine (C₆H₅NH₂) is called aniline.

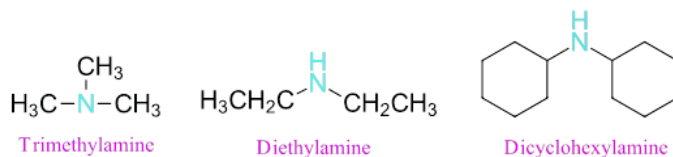


Other primary amines tend to be named as alkanamines. The alkyl group is named as an alkane (**prefix+ane**) and -e ending is replaced with the suffix -**amine**. The -e ending is not removed for diamines.



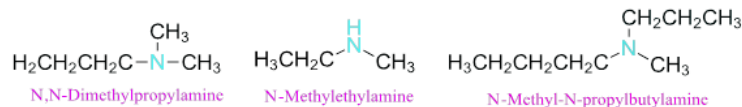
NOMENCLATURE OF SYMMETRICAL SECONDARY AND TERTIARY AMINES

Symmetrical 2° and 3° amines (where all substituents are identical) are named as alkylamines and the prefix di- or tri -added to indicate the number of substituents.



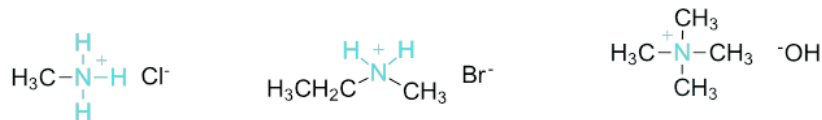
NOMENCLATURE OF UNSYMMETRICAL SECONDARY AND TERTIARY AMINES

Unsymmetrical 2° and 3° amines are named with the largest chain being the base chain (**prefix+yl+amine**). The other alkyl groups are named as N-substituents. This notation is used to indicate that the substituent is attached to the amine nitrogen and not an alkyl carbon.



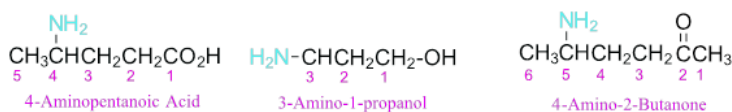
NOMENCLATURE OF AMMONIUM SALTS

Ammonium salts and quaternary ammonium salts are named using the same rules as 2° and 3° amines except the -amine suffix is replaced with -ammonium + the name of the counter ion. The counter ion name is separated with a space.



Methylammonium Chloride N-Methylethylammonium Bromide Tetramethylammonium Hydroxide

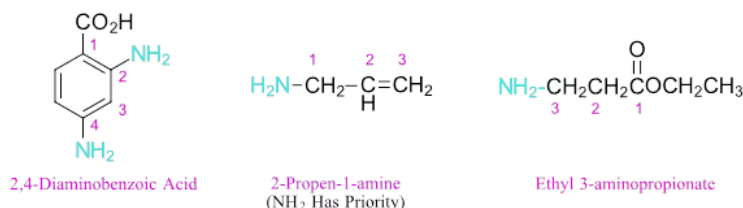
Amines have one of the lower functional group priorities in the IUPAC nomenclature system. When present in a compound with a functional group of higher priority, the amine group is named as a substituent called “amino.”



4-Aminopentanoic Acid

3-Amino-1-propanol

4-Amino-2-Butanone

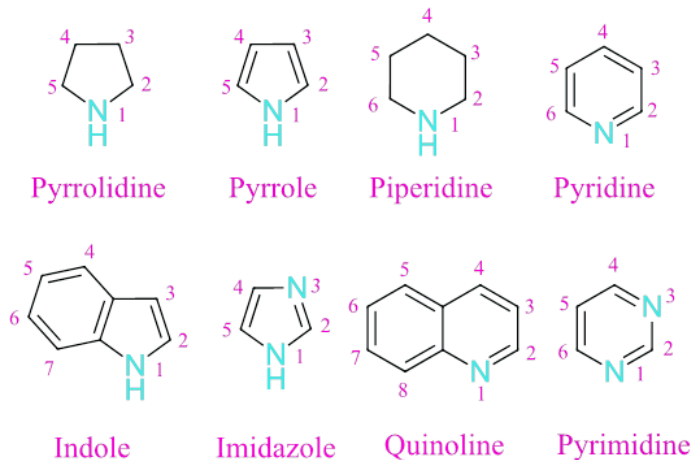


2,4-Diaminobenzoic Acid

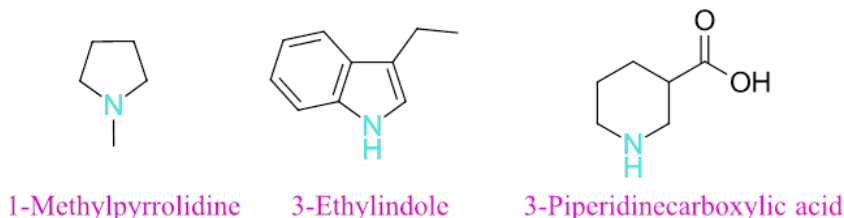
2-Propen-1-amine
(NH₂ Has Priority)

Ethyl 3-aminopropionate

Heterocyclic amines have one or more nitrogens as part of the ring and can be aliphatic or aromatic. Most heterocyclic amine ring systems have a common name and are numbered such that a nitrogen always gets position 1. An amine attached to a heterocyclic ring is named as an amino substituent.



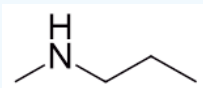
EXAMPLE



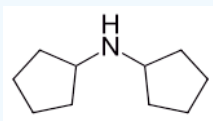
? EXERCISES 24.1.1

Name the following compounds:

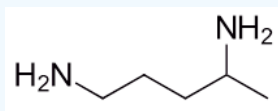
a)



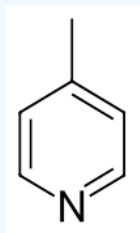
b)



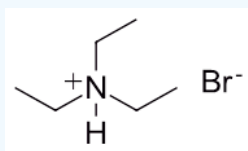
c)



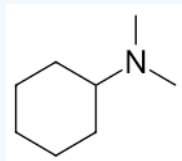
d)



e)



f)



Answers

- N-Methylpropylamine
- Dicyclopentylamine
- 1,4-Pentanediamine
- 4-Methylpyridine
- Triethylammonium Bromide
- N,N-Dimethylcyclohexylamine

? EXERCISE 24.1.1

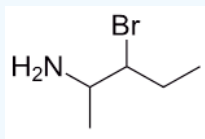
Draw the structures corresponding to the following names:

- 3-Bromo-pentan-2-amine
- Cyclopentanamine

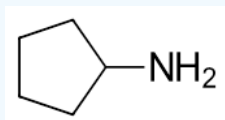
- c. *Trans*-3-ethylcyclohexanamine
- d. *Sec*-butyl-*tert*-butyl amine
- e. N,N-Dimethyl-3-pentanamine
- f. 4-Methyl-2-hexanamine
- g. 6-Bromo-4-amino-2-heptanol3)

Answer

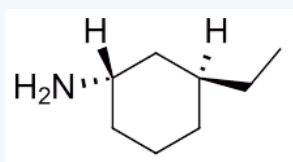
a)



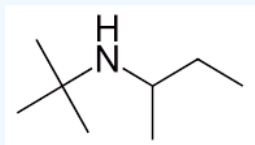
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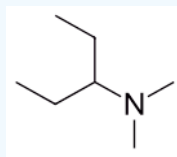
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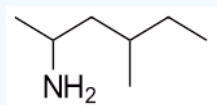
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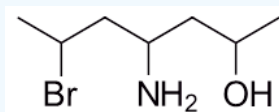
e)



f)



g)



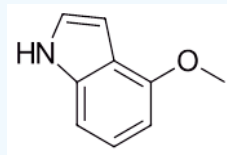
? EXERCISE 24.1.3

Draw the structures of the following heterocyclic compounds:

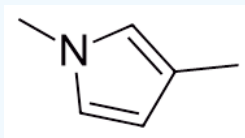
- 4-Methoxyindole
- 1,4-Dimethylpyrrole
- 3-(N,N-Dimethylamino)pyridine
- 2-Aminopyrimidine

Answer

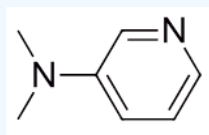
a)



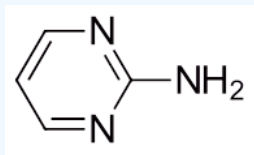
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c)



d)



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