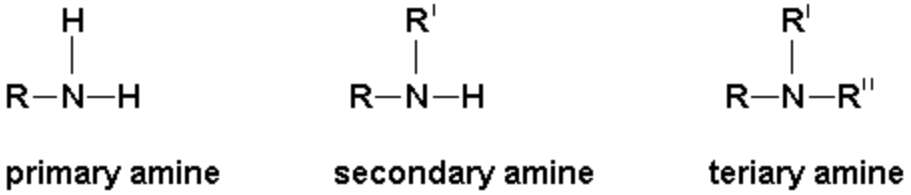
# 5.6: Amines and Amides

An **amine** may be considered to be an ammonia molecule in which one or more hydrogen atoms are replaced by alkyl groups.

**Amides** are compounds that are formed when an amine react with a carboxylic acid.

**Naming Amines**

Amines may have one, two, or three alkyl groups attached to the nitrogen atom. These amines are called primary, secondary, and tertiary amines, respectively.




The first part is *amino*-, and the second part comes from the longest chain hydrocarbon.

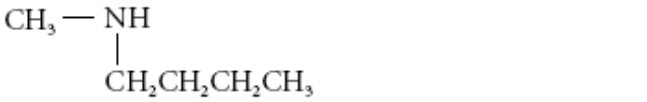
For example, $CH_3NH_2$ has one carbon atom, so its name is *aminomethane*.

When there are more than two carbon atoms in the chain, however, you have to specify the carbon to which the nitrogen is attached.

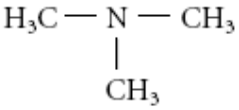
Another system for naming amines includes the suffix *–amine*, preceded by the name of the alkyl group. So our previous example would be *methylamine*.

Molecules with 2 amino groups are called diamines, and the IUPAC name for cadaverine is 1,5-diaminopentane.

The IUPAC names for 2° and 3° amines include the *N*- prefix to denote the substituted groups on the N atom of the amino group.



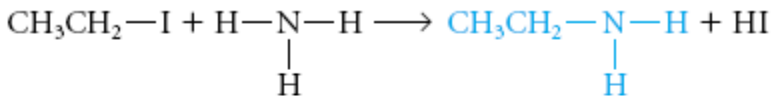
N-methyl-1-aminobutane (methyl-*n*-butylmethylamine); a 2° amine



*N*,*N*-dimethylaminomethane (trimethylamine), a 3° amine

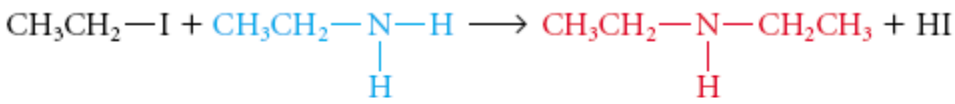
**Preparing Amines**

Amines can be prepared by the reaction of ammonia, which is a weak base, with an alkyl halide. For example, the reaction of ammonia with ethyl iodide (iodoethane) yields ethylamine.



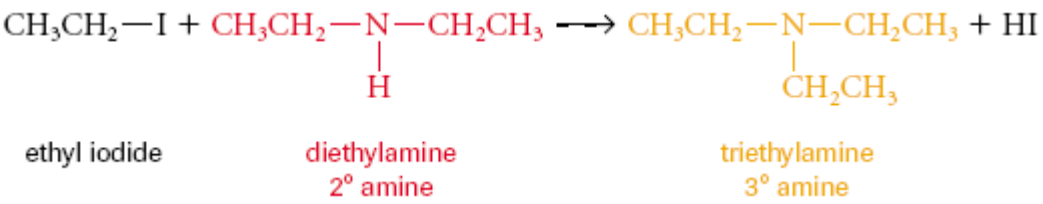
ethyl iodide ammonia ethylamine 1° amine

The ethylamine formed is a primary amine that can also react with alkyl halides—in this case, the ethyl iodide already present in the reaction mixture. Thus, the secondary amine diethylamine is formed.



ethyl iodide ethylamine 1° amine diethylamine 2° amine

This last product can also react with the ethyl iodide to produce the tertiary amine, triethylamine.




The final product is a mixture of primary, secondary, and tertiary amines. The components can be separated by fractional distillation by virtue of their different boiling points; however, this is generally not a useful method for the synthesis of primary amines. We will not be looking at these other methods.

Amines are organic bases, and can react with carboxylic acids to form nitrogenous organic "salts," called amides.

**Amides**

Amides are structurally similar to esters, with a N atom replacing the O atom in the chain of an ester. The amide functional group consists of a carbonyl group directly attached to an N atom.

The amide linkage is of major importance in biological systems as it forms the backbone of all protein molecules. In proteins, the amide bonds are called peptide bonds, and it is the forming and breaking of these bonds that gives specificity to the proteins and their functions.

**Naming Amides**

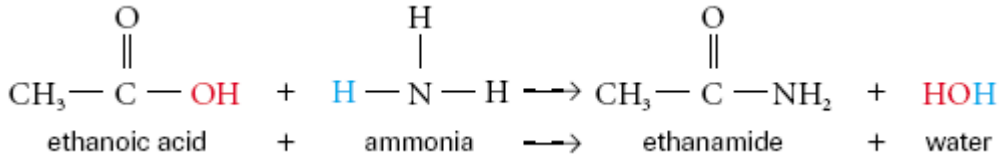
Naming amides is similar to naming esters. While esters end in *–oate*, amides end in *–amide*.

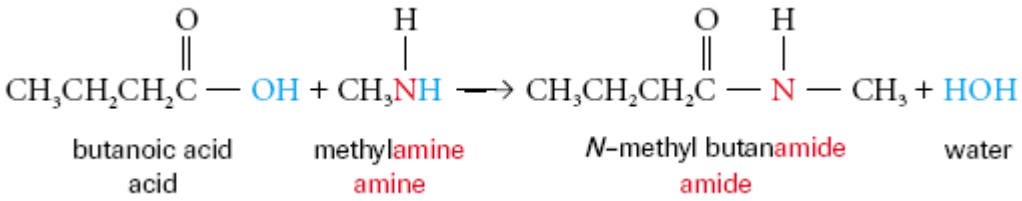
Butanoic acid + methanol → methyl butanoate + water

Butanoic acid + aminomethane → methyl buanamide + water

**Preparing Amides from Amines: Condensation Reactions**

Carboxylic acids react with ammonia or with 1° and 2° amines to produce amides.






*When one or more alkyl groups are attached to the N atom in the amide linkage, the italicized uppercase letter *N* is used to clarify the location of the group.

**Properties of Amines and Amides**

Amines have higher boiling points and melting points than similar sized hydrocarbons, and smaller amines are readily soluble in water. Amides are generally insoluble in water.

SCH4C

## Worksheet 5.6: Amines and Amides

1. Write two names for each of the following structures, and indicate whether they are $1^o$, $2^o$, or $3^o$ amines.

(a) $CH_3CH_2NHCH_2CH_3$

(b) $CH_3CH_2N(CH_2CH_3)$ with a $CH_2CH_3$ branch

(c) $CH_3CH(NH_2)CH_3$

(d) $CH_3(CH_2)_5NH_2$

(e) $CH_3NH$ with a $CH_2CH_2CH_2CH_2CH(Br)CH_3$ branch

2. Draw structural diagrams for each of the following compounds:

(a) 2,5-diaminohexane
(b) dimethylethylamine
(c) a tertiary amine with four C atoms
(d) 1,2,4-triaminobenzene
(e) two primary amines that are isomers of dimethylethylamine

3. Write the IUPAC name for each of the following compounds:

(a) $CH_3CH_2CH_2C(=O)-N(H)-CH_2CH_3$

(b) $CH_3CH_2C(=O)-NH-CH_3$

(c) $CH_3CH_2C(=O)-N(CH_3)-CH_3$

(d) $CH_3(CH_2)_3CON(CH_2CH_3)CH_3$

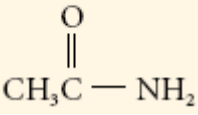
SCH4C

4. Draw structures for the following amides:

(a) *N,N*-dimethyl hexanamide
(b) *N*-methyl acetamide
(c) hexanamide
(d) *N*-isopropyl-*N*-methyl butanamide

5. Classify each of the following compounds as amines or amides, and write the IUPAC name for each:

(a) $CH_3CH_2CH_2NH_2$
(b) $CH_3NHCH_2CH_3$
(c)



6. Proteins are built from many smaller molecules, each of which contains an amine group and a carboxylic acid group; these small molecules are called amino acids.

(a) Draw structural diagrams for the amino acids glycine (2-aminoethanoic acid) and alanine (2-aminopropanoic acid).
(b) Draw structural diagrams for two possible products of the condensation reaction between glycine and alanine.