C–O CHEMICAL GROUPS

Many biological compounds contain a carbon bonded to an oxygen. For example,

**alcohol**

\[ \text{alcohol} = \text{C–H}\text{O} \]

The –OH is called a hydroxyl group.

**aldehyde**

\[ \text{aldehyde} = \text{C–H} \text{O} \]

The C=O is called a carbonyl group.

**ketone**

\[ \text{ketone} = \text{C–C=O} \]

**carboxylic acid**

\[ \text{carboxylic acid} = \text{C–C=O} \]

The –COOH is called a carboxyl group. In water this loses an H⁺ ion to become –COO⁻.

**esters**

Esters are formed by combining an acid and an alcohol.

\[ \text{acid} + \text{alcohol} \rightarrow \text{ester} + \text{H₂O} \]

C–N CHEMICAL GROUPS

Amines and amides are two important examples of compounds containing a carbon linked to a nitrogen.

**Amines** in water combine with an H⁺ ion to become positively charged.

\[ \text{amine} + \text{H}^+ \rightarrow \text{amine}^+ \]

**Amides** are formed by combining an acid and an amine. Unlike amines, amides are uncharged in water. An example is the peptide bond that joins amino acids in a protein.

\[ \text{acid} + \text{amine} \rightarrow \text{amide} + \text{H₂O} \]

Nitrogen also occurs in several ring compounds, including important constituents of nucleic acids: purines and pyrimidines.

\[ \text{cytosine (a pyrimidine)} \]

PHOSPHATES

Inorganic phosphate is a stable ion formed from phosphoric acid, H₃PO₄. It is often written as Pᵢ.

Phosphate esters can form between a phosphate and a free hydroxyl group. Phosphate groups are often attached to proteins in this way.

\[ \text{also written as } \text{P} \]

The combination of a phosphate and a carboxyl group, or two or more phosphate groups, gives an acid anhydride.

\[ \text{high-energy acyl phosphate bond (carboxylic–phosphoric acid anhydride) found in some metabolites} \]

\[ \text{phosphoanhydride—a high-energy bond found in molecules such as ATP} \]

\[ \text{also written as } \text{P} \]