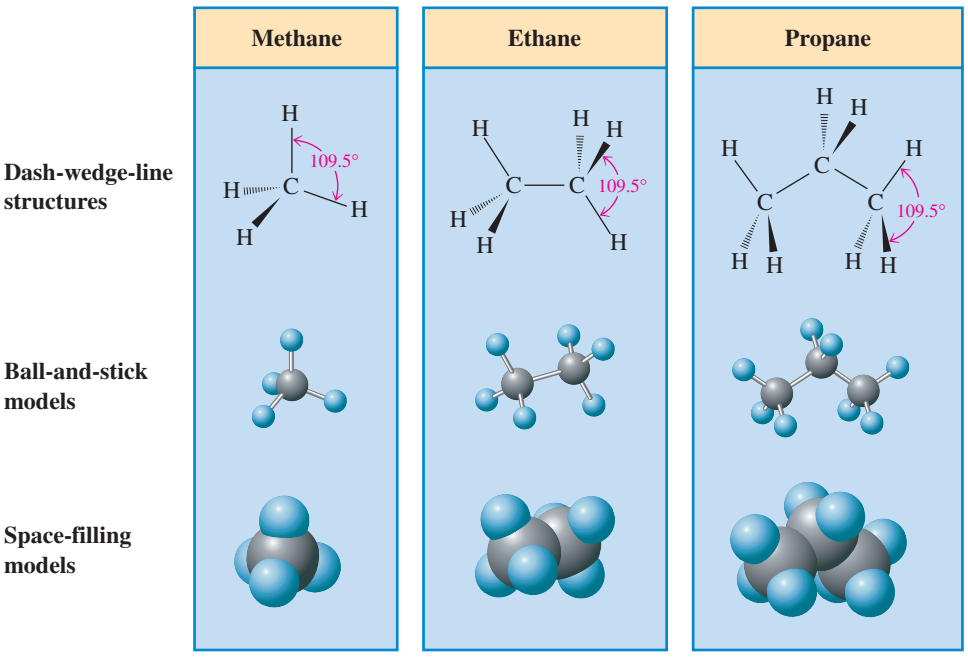


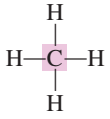
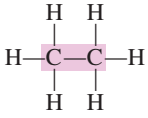
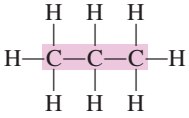

**Figure 12.3** Three different three-dimensional ways of representing the structures of methane, ethane, and propane: dash-wedge-line structure, ball-and-stick model, and space-filling model.

are given in Figure 12.3. They are dash-wedge-line structures, ball-and-stick models, and space-filling models. Note how each carbon atom in each of the models participates in four bonds (Section 12.2). Note also that the geometrical arrangement of atoms about each carbon atom is tetrahedral, an arrangement consistent with the principles of VSEPR theory (Section 5.8). The tetrahedral arrangement of the atoms bonded to alkane carbon atoms is fundamental to understanding the structural aspects of organic chemistry.

## 12.5 STRUCTURAL FORMULAS

The structures of alkanes, as well as other types of organic compounds, are generally represented in two dimensions rather than three (Figure 12.3) because of the difficulty in drawing the latter. These two-dimensional structural representations make no attempt to portray accurately the bond angles or molecular geometry of molecules. Their purpose is to convey information about which atoms in a molecule are bonded to which other atoms.

Two-dimensional structural representations for organic molecules are called structural formulas. A **structural formula** *is a two-dimensional structural representation that shows how the various atoms in a molecule are bonded to each other.* Structural formulas are of two types: expanded structural formulas and condensed structural formulas. An **expanded structural formula** *is a structural formula that shows all atoms in a molecule and all bonds connecting the atoms.* When written out, expanded structural formulas generally occupy a lot of space, and condensed structural formulas represent a shorthand method for conveying the same information. A **condensed structural formula** *is a structural formula that uses groupings of atoms, in which central atoms and the atoms connected to them are written as a group, to convey molecular structural information.* The expanded and condensed structural formulas for methane, ethane, and propane follow.

| | Methane | Ethane | Propane |
|---|---|---|---|
| Expanded structural formula |  |  |  |
| Condensed structural formula | $CH_4$ | $CH_3—CH_3$ | $CH_3—CH_2—CH_3$ |

Structural formulas, whether expanded or condensed, do not show the geometry (shape) of the molecule. That information can be conveyed only by 3-D drawings or models such as those in Figure 12.3.