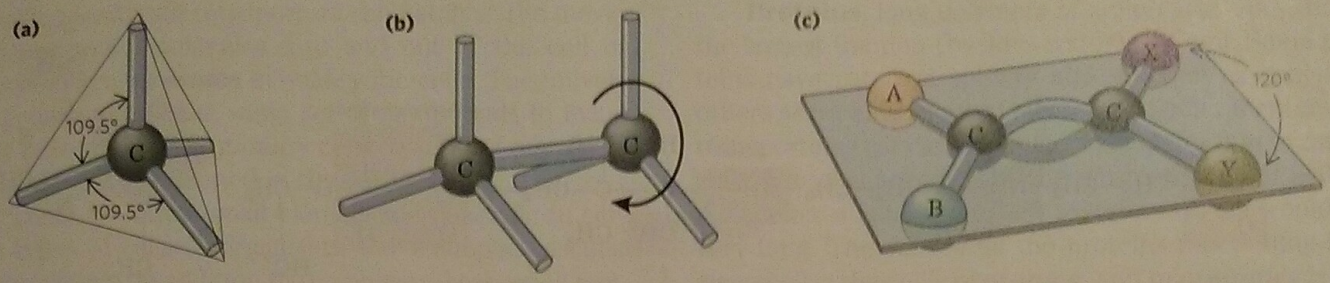

FIGURE 1–15 Geometry of carbon bonding. (a) Carbon atoms have a characteristic tetrahedral arrangement of their four single bonds. **(b)** Carbon–carbon single bonds have freedom of rotation, as shown for the compound ethane ($CH_3—CH_3$). **(c)** Double bonds are shorter and do not allow free rotation. The two doubly bonded carbons and the atoms designated A, B, X, and Y all lie in the same rigid plane.

Methyl

Ethyl

Phenyl

Carbonyl (aldehyde)

Carbonyl (ketone)

Carboxyl

Hydroxyl (alcohol)

Enol

Ether

Ester

Acetyl

Anhydride (two carboxylic acids)

Amino (protonated)

Amido

Imine

N-Substituted imine (Schiff base)

Guanidinium

Imidazole

Sulfhydryl

Disulfide

Thioester

Phosphoryl

Phosphoanhydride

Mixed anhydride (carboxylic acid and phosphoric acid; also called acyl phosphate)

FIGURE 1–16 Some common functional groups of biomolecules. Functional groups are screened with a color typically used to represent the element that characterizes the group: gray for C, red for O, blue for N, yellow for S, and orange for P. In this figure and throughout the book, we use R to represent "any substituent." It may be as simple as a hydrogen atom, but typically it is a carbon-containing group. When two or more substituents are shown in a molecule, we designate them R^1, R^2, and so forth.