Water also attracts other polar molecules, such as sugars or ions, by forming hydrogen bonds. We call a polar substance that interacts readily with or dissolves in water **hydrophilic** (hydro- = "water"; -philic = "loving"). In contrast, nonpolar molecules such as oils and fats do not interact or dissolve well with water, as shown in Figure 2.24. A good example of this is vegetable oil poured into a glass of water (Figure 2.25). We call such nonpolar substances **hydrophobic** (hydro- = "water"; -phobic = "fearing"). Hydrophobic molecules readily dissolve or interact with other molecules that are also hydrophobic. Some molecules have both hydrophobic and hydrophilic regions as a result of the atoms that make the molecule up. Phospholipids, the major component of the cell membrane, have both a hydrophilic and a hydrophobic region. Phospholipids will be discussed more in chapter 3.

Figure 2.24 As this macroscopic image of oil and water shows, oil is a nonpolar compound and, hence, will not dissolve in water. (credit: Gautam Dogra/ Biology 2E OpenStax)

Figure 2.25 Oil and water separate due to their inability to chemically interact. (credit: Victor Blacus/ Wikimedia Commons)

Water Stabilizes Temperature

The hydrogen bonds in water allow it to absorb and release heat energy more slowly than many other liquids and substances. **Temperature** measures the motion of molecules. As the motion increases, energy is higher, and therefore the temperature is higher. Water can absorb a great deal of energy before its temperature rises due to a large number of hydrogen bonds that hold water molecules together. This means that water can moderate temperature changes both within organisms and within different environments. As energy input continues, the balance between hydrogen-bond formation and destruction swings toward the destruction side. More bonds are broken than are formed, and individual water molecules can be released. The release of individual water molecules at the surface of a liquid (such as a body of water, the leaves of a plant, or the skin of an organism) is known as the process of **evaporation**. For example, when humans exercise, their skeletal muscles generate a considerable amount of heat energy. One way humans maintain their temperature homeostasis is by producing sweat using their sudoriferous glands. Sweat, which is 90 percent water, allows for the cooling of an organism because breaking hydrogen bonds in liquid sweat requires a large input of heat energy. Once the sweat begins to evaporate, it takes the heat energy away from the body, which results in a cooling effect.

Conversely, as molecular motion decreases and temperatures drop, less energy is present to break the hydrogen bonds between water molecules. These bonds remain intact and begin to form a rigid, lattice-like structure (e.g., ice) (Figure 2.26a). When frozen, ice is less dense than liquid water, meaning it floats (Figure 2.26b). This can be explained by the fact that when the temperature is cool, water molecules can form the maximum amount of hydrogen bonds, and the individual water molecules are spaced farther apart. In lakes, ponds, and oceans, ice will form on the surface of the water, creating an insulating barrier which protects the animal and plant life that lives beneath the surface of the water. If this did not happen, plants and animals living in the water would freeze into a block of ice and would not be able to move around freely, making life in cold temperatures difficult, if not impossible.

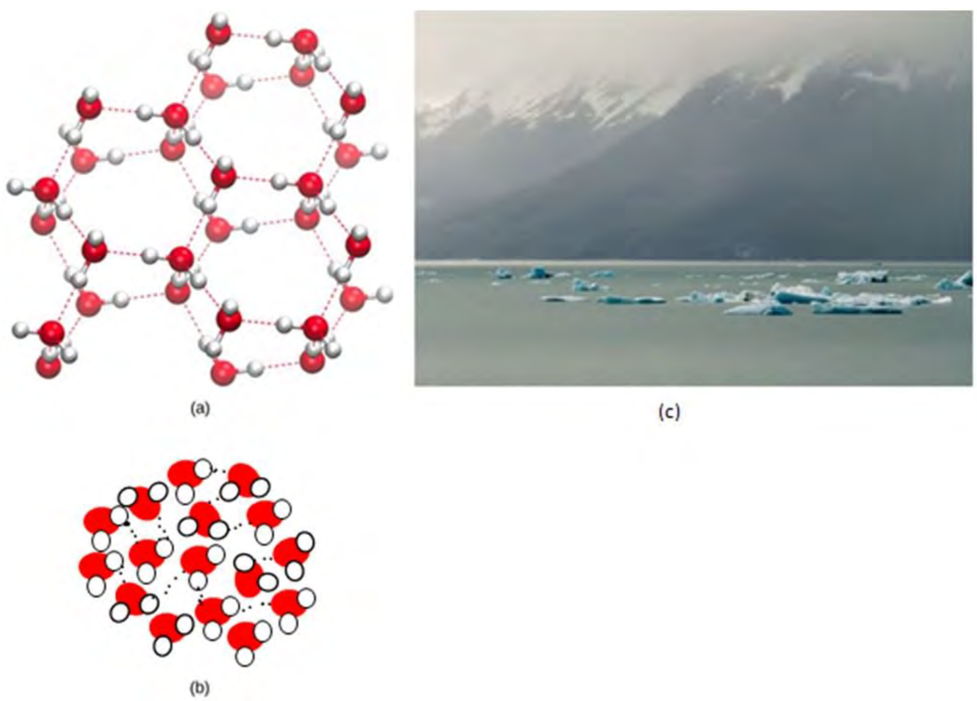

Figure 2.26 (a) Shows the lattice-like molecular structure of ice. (b) In liquid form water molecules pack tightly making it denser c) Shows ice (a) as it floats on liquid water (b). (credit a: modification of work by Jane Whitney; credit b: Elizabeth O'Grady c: modification of work by Carlos Ponte/ Biology 2E OpenStax)

Water Is an Excellent Solvent

Because water is polar, with slightly positive and negative charges, ionic compounds and polar molecules can readily dissolve in it. Water is, therefore, referred to as a **solvent,** a substance capable of dissolving another substance. The **solute** is defined as the substance being dissolved. Together the solute and the solvent make up a **solution**.

In the case of table salt, NaCl, mixed in water, the sodium and chloride ions separate, or dissociate, in the water. The ions remain separated because each independently forms hydrogen bonds with the surrounding water molecules (Figure 2.27). A positively charged sodium ion is surrounded by the partially negative charges of oxygen atoms in water molecules. A negatively charged chloride ion is surrounded by the partially positive charges of hydrogen atoms in water molecules. If the water is removed, for example, by boiling the solution, the sodium and chloride ions will once again form ionic bonds, and salt crystals will reform.

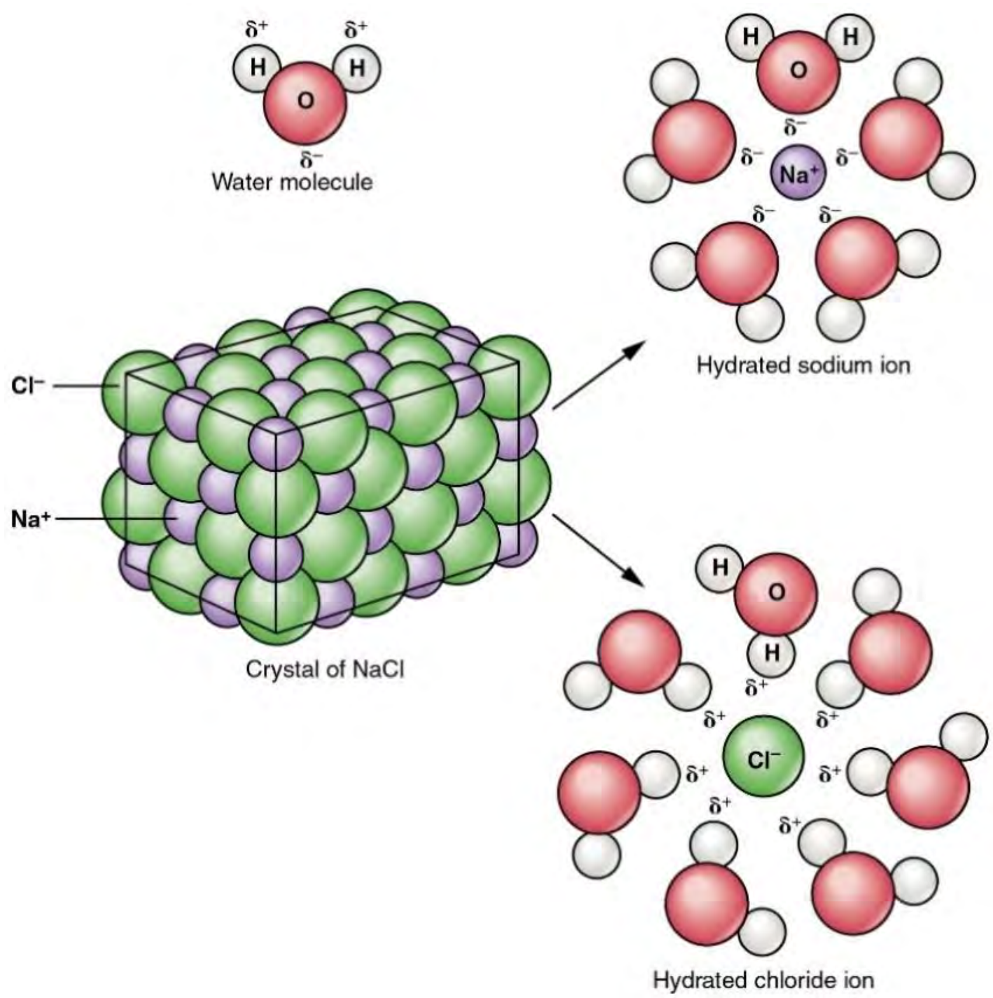

Figure 2.27 Dissociation of Sodium Chloride in Water. Notice that the crystals of sodium chloride dissociate not into molecules of NaCl, but into Na+ cations and Cl– anions, each surrounded by water molecules. (credit: Betts et al./Anatomy and Physiology OpenStax)