of two or more molecules. Symporters, also referred to as cotransporters, move two or more molecules across a cellular barrier in the same direction, whereas antiporters, also referred to as exchangers or counter-transporters, move two or more molecules in opposite directions.

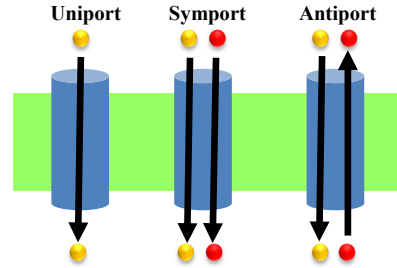

FIGURE 3.41 Uniporters move a single molecule in one direction down a concentration gradient, while symporters and antiporters move multiple molecules. Symporters move molecules in the same direction, while antiporters move molecules in opposite directions.

Membrane transporters can also be categorized according to their use of passive or active transport systems. In passive transport systems, facilitated diffusion occurs. Binding of a solute compound leads to conformational changes that transfer the solute from an area of high solute concentration to an area of low solute concentration (down the concentration

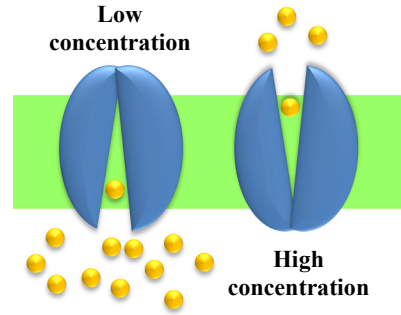

FIGURE 3.42 Facilitated diffusion moves a solute down a concentration gradient without expending cellular energy. Binding of the solute molecule induces conformational changes that move the solute across the membrane at a rate substantially greater than possible by simple diffusion.

gradient, Figure 3.42). Since this process is entropy driven, it does not require the expenditure of cellular energy (e.g., cleavage of ATP to ADP). The transport of glucose into erythrocytes, for example, employs a uniporter that employs passive diffusion. Erythrocyte glucose transporters, also referred to as GLUT-1, 2, 3, 4, and 5, increase the rate of passage of glucose across the cellular membrane by a factor of 50,000 relative to simple diffusion. No energy input is required, as the flow of glucose into erythrocytes moves down the concentration gradient.[98]

Erythrocytes also contain an antiporter system that operates through a facilitated diffusion event, the chloride–bicarbonate exchanger, more commonly referred to as anion exchanger 1 (AE1) or the band 3 protein. This membrane transporter is critical to the elimination of carbon dioxide