13.1: Prelude to Equilibrium

Imagine a beach populated with sunbathers and swimmers. As those basking in the sun get too hot and want to cool off, they head into the surf to swim. As the swimmers tire, they head to the beach to rest. If these two rates of transfer (sunbathers entering the water, swimmers leaving the water) are equal, the number of sunbathers and swimmers would be constant, or at equilibrium, although the identities of the people are constantly changing from sunbather to swimmer and back. An analogous situation occurs in chemical reactions. Reactions can occur in both directions simultaneously (reactants to products and products to reactants) and eventually reach a state of balance.

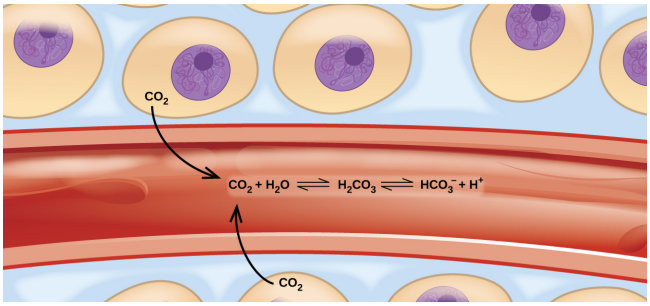

Figure 13.1.1: Movement of carbon dioxide through tissues and blood cells involves several equilibrium reactions.

An image depicts three tan squares, lying side-by-side along the upper left corner. Two of the same squares also lie side-by-side in the lower right corner. Each square has a black dot in the center. One of the squares is labeled, “C O subscript 2,” and has a double-headed arrow pointing from it to a red tube-like structure that runs between the squares across the image from the upper right to the lower left. This arrow is labeled, “C O subscript 2 dissolved in plasma.” The red tube has two round red shapes in it, and the upper one is labeled, “C O subscript 2 carried in red blood cells.” The gaps between the squares and the red tube are colored light blue. One of the squares along the top of the image is labeled, “C O subscript 2,” and is connected by a double-headed arrow to an equation in the red tube that is labeled, “C O subscript 2, a plus sign, H subscript 2 O, right-facing arrow, H subscript 2 C O subscript 3, right-facing arrow, H C O subscript 3 superscript negative sign, plus sign, H superscript positive sign.” The compound “H C O subscript 3 superscript negative sign” is then connected by a double-headed arrow to the space in the red tube and is labeled, “H C O subscript 3 superscript negative sign dissolved in plasma as carbonic acid.”

These balanced two-way reactions occur all around and even in us. For example, they occur in our blood, where the reaction between carbon dioxide and water forms carbonic acid (HCO_3^-) (Figure 13.1.1). Human physiology is adapted to the amount of ionized products produced by this reaction (HCO_3^- and H^+). In this chapter, you will learn how to predict the position of the balance and the yield of a product of a reaction under specific conditions, how to change a reaction's conditions to increase or reduce yield, and how to evaluate an equilibrium system's reaction to disturbances.