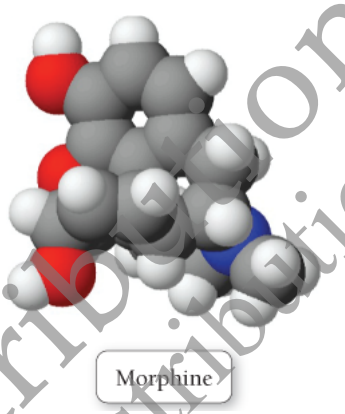
Pearson

5.1: Morphine: A Molecular Impostor

Morphine—a drug named after Morpheus, the Greek god of dreams—is the silver bullet in the human arsenal against pain. Morphine is often prescribed after surgery to aid recovery or to alleviate the severe pain associated with illnesses such as cancer. It is also prescribed to patients who have chronic pain toward the end of their lives. For these patients, prescribed morphine provides relief from an otherwise tortuous existence.

Morphine is a natural product derived from the sap of the opium poppy. The effects of opium sap have been known for thousands of years, but morphine itself was not isolated from opium until the early 1800s. Morphine acts by binding to receptors (called opioid receptors) that exist within nerve cells. When morphine binds to an opioid receptor, the transmission of nerve signals is altered, resulting in less pain, sedation, and feelings of euphoria and tranquility.



Endogenous means produced within the organism.

Why do humans (and other mammals) have receptors within their nerve cells that bind to molecules derived from the sap of a plant? Researchers long suspected that these receptors must also bind other molecules as well; otherwise, why would the receptors exist? In the 1970s, researchers discovered some of these molecules, known as endorphins (short for **end**ogenous mor**phine**). Endorphins are the body's natural painkillers. Our bodies naturally produce endorphins during periods of pain such as childbirth or intense exercise. Endorphins are at least partially responsible for the so-called runner's high, a feeling of well-being that often follows an athlete's intense workout.

Morphine binds to opioid receptors because it fits into a special pocket (called the active site) on the opioid receptor protein (just as a key fits into a lock) that normally binds endorphins. Certain parts of the morphine molecule have a similar enough shape to endorphins that they fit the lock (even though they are not the original key). In other words, morphine is a *molecular impostor*, mimicking the action of endorphins because of similarities in shape.

The lock-and-key fit between the active site of a protein and a particular molecule is important not only to our perception of pain, but to many other biological functions as well. Immune response, the sense of smell, the sense of taste, and many types of drug action depend on shape-specific interactions between molecules and proteins. Our ability to determine the shapes of key biological molecules is largely responsible for the revolution that has occurred in biology over the last 50 years.

> *Proteins* are among the most important biological molecules and serve many functions in living organisms.

In this chapter, we look at ways to predict and account for the shapes of molecules. The molecules we examine

are much smaller than the protein molecules we just discussed, but the same principles apply to both. The simple model we examine to account for molecular shape is valence shell electron pair repulsion (VSEPR) theory, and in this chapter we use it in conjunction with the Lewis model to make important predictions about the shapes of molecules.