Every year in Pamplona, Spain, many people experience what some consider the ultimate “adrenaline rush.” Fighting bulls and steers run through the town every morning of a nine-day fiesta. Hundreds of revelers literally run with the bulls. The bull-racing ritual is inhumane (more than 50 bulls are killed each day), and participants risk death if they should get gored by a bull. Why do people do it?

Many do it for the “rush.” The rush comes from a hormone secreted by the endocrine system called adrenaline or epinephrine. The adrenal hormone declares an emergency situation to the body, requiring the body to become very active.
THE ENDOCRINE GLANDS

The nervous system is one of two communication systems for sending information to and from the brain. The second is the endocrine system. The endocrine system sends chemical messages, called hormones. The hormones are produced in the endocrine glands and are distributed by the blood and other body fluids. (The names and locations of these glands are shown in Figure 6.11.) Hormones circulate throughout the bloodstream but are properly received only at a specific site: the particular organ of the body that they influence. The endocrine glands are also called ductless glands because they release hormones directly into the bloodstream. In contrast, the duct glands release their contents through small holes, or ducts, onto the surface of the body or into the digestive system. Examples of duct glands are sweat glands, tear glands, and salivary glands.

Hormones have various effects on your behavior. They affect the growth of bodily structures such as muscles and bones, so they affect what you can do physically. Hormones affect your metabolic processes; that is, they can affect how much energy you have to perform actions. Some hormonal effects take place before you are born. Essentially all the physical differences between boys and girls are caused by a hormone called testosterone. Certain other hormones are secreted during stressful situations to prepare the body for action. Hormones also act in the brain to directly influence your moods and drives.

Pituitary Gland

Directed by the hypothalamus, the pituitary gland acts as the master gland. The pituitary gland, located near the midbrain and the hypothalamus, secretes a large number of hormones, many of which control the output of hormones by other endocrine glands. The hypothalamus monitors the amount of hormones in the blood and sends out messages to correct imbalances.

What do these hormone messages tell the body to do? They carry messages to organs involved in regulating and storing nutrients so that despite changes in conditions outside the body, cell metabolism can continue on an even course. They also control growth and reproduction, including ovulation and lactation (milk production) in females.

Thyroid Gland

The thyroid gland produces the hormone thyroxine. Thyroxine stimulates certain chemical reactions that are important for all tissues of the body. Too little thyroxine makes people feel lazy and lethargic—a
condition known as hypothyroidism. Too much thyroxine may cause people to lose weight and sleep and to be overactive—a condition known as hyperthyroidism.

**Adrenal Glands**

The adrenal glands become active when a person is angry or frightened. They release epinephrine and norepinephrine (also called adrenaline and noradrenaline) into the bloodstream. These secretions cause the heartbeat and breathing to increase. They can heighten emotions, such as fear and anxiety. These secretions and other changes help a person generate the extra energy he or she needs to handle a difficult situation.

The adrenal glands also secrete cortical steroids. Cortical steroids help muscles develop and cause the liver to release stored sugar when the body requires extra energy for emergencies.

**Sex Glands**

There are two types of sex glands—testes in males and ovaries in females. Testes produce sperm and the male sex hormone testosterone. Low levels of testosterone are also found in females. Ovaries produce eggs and the female hormones estrogen and progesterone, although low levels of these hormones are also found in males.

Testosterone is important in the physical development of males, especially in the prenatal period and in adolescence. In the prenatal period, testosterone helps decide the sex of a fetus. In adolescence, testosterone is important for the growth of muscle and bone along with the growth of male sex characteristics.

Estrogen and progesterone are important in the development of female sex characteristics. These hormones also regulate the reproductive cycle of females. The levels of estrogen and progesterone vary throughout the menstrual cycle. These variances can cause premenstrual syndrome (PMS) in some women. PMS includes symptoms such as fatigue, irritability, and depression.

**HORMONES VS. NEUROTRANSMITTERS**

Both hormones and neurotransmitters work to affect the nervous system. In fact, the same chemical (such as norepinephrine) can be used as both a hormone and a neurotransmitter. So what is the difference between a hormone and a neurotransmitter?
When a chemical is used as a neurotransmitter, it is released right beside the cell that it is to excite or inhibit. When a chemical is used as a hormone, it is released into the blood, which diffuses it throughout the body. For example, norepinephrine is a hormone when it is secreted into the blood by the adrenal glands. Norepinephrine is a neurotransmitter, though, when it is released by the sympathetic motor neurons of the peripheral nervous system.

Hormones and neurotransmitters appear to have a common evolutionary origin (Snyder, 1985). As multicellular organisms evolved, the system of communication among cells coordinated their actions so that all the cells of the organism could act as a unit. As organisms grew more complex, this communication system began to split into two more specialized communication systems. One, the nervous system, developed to send rapid and specific messages, while the other, involving the circulatory system, developed to send slow and widespread communication. In this second system, the chemical messengers evolved into hormones. Whereas neural messages can be measured in thousandths of a second, hormonal messages may take minutes to reach their destination and weeks or months to have their total effect.

**Figure 6.12 An Adrenaline Rush**

In the event of a life-threatening or highly stressful situation, the adrenal glands produce adrenaline to give people the necessary energy to cope. *How does adrenaline affect emotions in people?*

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**SECTION 3**

**Assessment**

1. **Review the Vocabulary** What are three ways that the endocrine system affects behavior?

2. **Visualize the Main Idea** In a chart similar to the one at right, identify the hormones produced by the glands and the functions of those hormones.

3. **Recall Information** How does the endocrine system differ from the nervous system?

<table>
<thead>
<tr>
<th>Glands of the Endocrine System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gland</td>
</tr>
<tr>
<td>Hormone(s) released</td>
</tr>
</tbody>
</table>

4. **Think Critically** Explain what psychologists might learn about behavior by studying sex hormones.

5. **Application Activity** Describe a medical situation in which a psychologist would examine the thyroid gland. Describe the situation from the perspective of a patient.