

# Exercise 1: Endocrine



Figure 1.1 Post office boxes and the unique keys needed to unlock each one provide an analogy for how hormones act like 'keys' in the body to promote or inhibit nearly every biological process.

(Credit:www.unsplash.com)

## Exercise 1 Learning Goals

After completing this lab, you should be able to:

- Explain the relationship between the endocrine and nervous systems to maintain homeostasis
- Identify and locate the major organs & tissues of the endocrine system.
- Define hormone, endocrine, and feedback loop.
- Explain the basic differences between water- and lipid-soluble hormones.
- Identify the stimuli for release or inhibition of each major hormone.
- Identify the target tissue and outcome effect of each major hormone.

The endocrine system, along with the nervous system, is how organ systems throughout the body communicate within and to each other. Above all others, the endocrine and nervous system together have the primary responsibility of maintaining homeostasis throughout the body.

### Nervous vs. Endocrine Signaling

As you learned previously, the nervous system can send communications throughout the body via either electrical or chemical signaling. The electrical signals occur via electrical potentials sent along nerves and the chemical signals are via **neurotransmitters**. Neurotransmitters (NT) are small molecules which, when stimulated by an action potential, are released by the synaptic terminal of a neuron. NT then diffuse across the synaptic cleft, the space between the neuron they were released from and the neuron or muscle cell immediately adjacent that they will be acting upon, and bind with their specific receptor on the post-synaptic neuron or muscle cell. When a NT binds with its post-synaptic receptor, it can result in the continued propagation of electrical signaling or induce a change in cellular functioning. Due to the very limited distance and extremely short period of time they are active, NT are considered to be the body's rapid response system. Recall that the sympathetic division of the autonomic nervous system is often called the "fight-or-flight" response- this is an example of when NT are rapidly being released to allow an individual to respond to a threatening situation. When a physiological situation requires an immediate and rapid response, NT are involved. This is why the nervous system and the release of NT are associated with physiological reactions to the external environment (i.e. when a bear is chasing you; you hear a scary noise in the middle of the night; or if you show up unprepared to your A&P lab practical).

In contrast to the immediate, lightning-quick response of the nervous system- the **endocrine system** works more slowly. Since it uses only chemical signals, called **hormones**, and not electrical potentials- the endocrine system does not react as rapidly. Furthermore, hormones must travel through the body via the bloodstream to reach their target cells. This means that even the quickest endocrine responses can take several minutes to hours and most are even slower acting, taking several days to induce a change. Additionally, many hormones are able to interact with a variety of target cells throughout the body and therefore can produce a wide range of physiological outcomes depending on the tissue involved. Due to its slower, more measured pace of response- the endocrine system is associated with physiological reactions to the internal environment of the body (i.e. stimulating the release of a hormone when its levels are low; regulating changes in blood pressure; or responding to major events like childbirth).

## Structures of the Endocrine System

In contrast to the *exocrine* system of glands secreting their products into ducts which then convey them to their site of action (i.e. sweat, sebum, milk, salivary & digestive enzymes), the glands of the endocrine system secrete their hormones in a ductless manner directly into the interstitial fluid around them or into the bloodstream for transportation elsewhere in the body. There are many glands with primarily endocrine functions like the pituitary, thyroid, parathyroid, adrenal, and pineal glands. Others like the hypothalamus, pancreas, and most all others, including some not even discussed in this lab like the small intestine, stomach, adipose and bone tissue, have both endocrine and non-endocrine functions.

## Alternate Methods of Chemical Signaling

When an endocrine organ or tissue secretes its hormonal products into the interstitial (or extracellular) fluid surrounding it, the hormone may enter into a blood vessel and travel in a classic endocrine signaling fashion. If the hormone remains nearby and exerts its effects on cells within the same area where it was released, it is considered to be acting as a **paracrine hormone** (para-="nearby"). If acting only on a directly adjacent cell, it is a **juxtacrine hormone** (juxta-="next to"). When a hormone is produced but only acts upon the cell which created it, it is called an **autocrine hormone** (auto-="self").

## Mechanism for Control of Hormone Secretion

Because hormones have the ability to induce such a wide variety of and potentially lethal physiological responses if occurring improperly, it is important for the body to be able to control their secretion with great precision. The processes involved in controlling a specific hormones secretion is called a **feedback loop**. Feedback loops determine how the body and a hormone will respond in a given physiological situation and what outcome will occur. These are typically used in the frame of how to return the body to homeostasis when an imbalance has occurred, whether due to disease or normal everyday healthy disruptions.

Feedback loops fall into one of two categories- negative or positive. Least common of the two is the **positive feedback loop**. A positive feedback loop is reserved for special physiological circumstances because of its method of action where the release of a specific hormone causes MORE of the same hormone to be released. Examples of positive feedback loops are the release of oxytocin during childbirth which stimulates the uterine contractions necessary for the progression of labor or a nursing infant stimulating the production of prolactin for continued milk production by nursing. In both of these situations, a continuation (and potentially an increase) of the physiological response is desirable.

The most common method for hormone regulation is through **negative feedback loops**. In contrast to positive feedback, negative feedback loops stop the secretion of a hormone



once its levels have reached appropriate levels in the blood. It is a general rule that most every hormone is regulated through some version of a negative feedback loop.

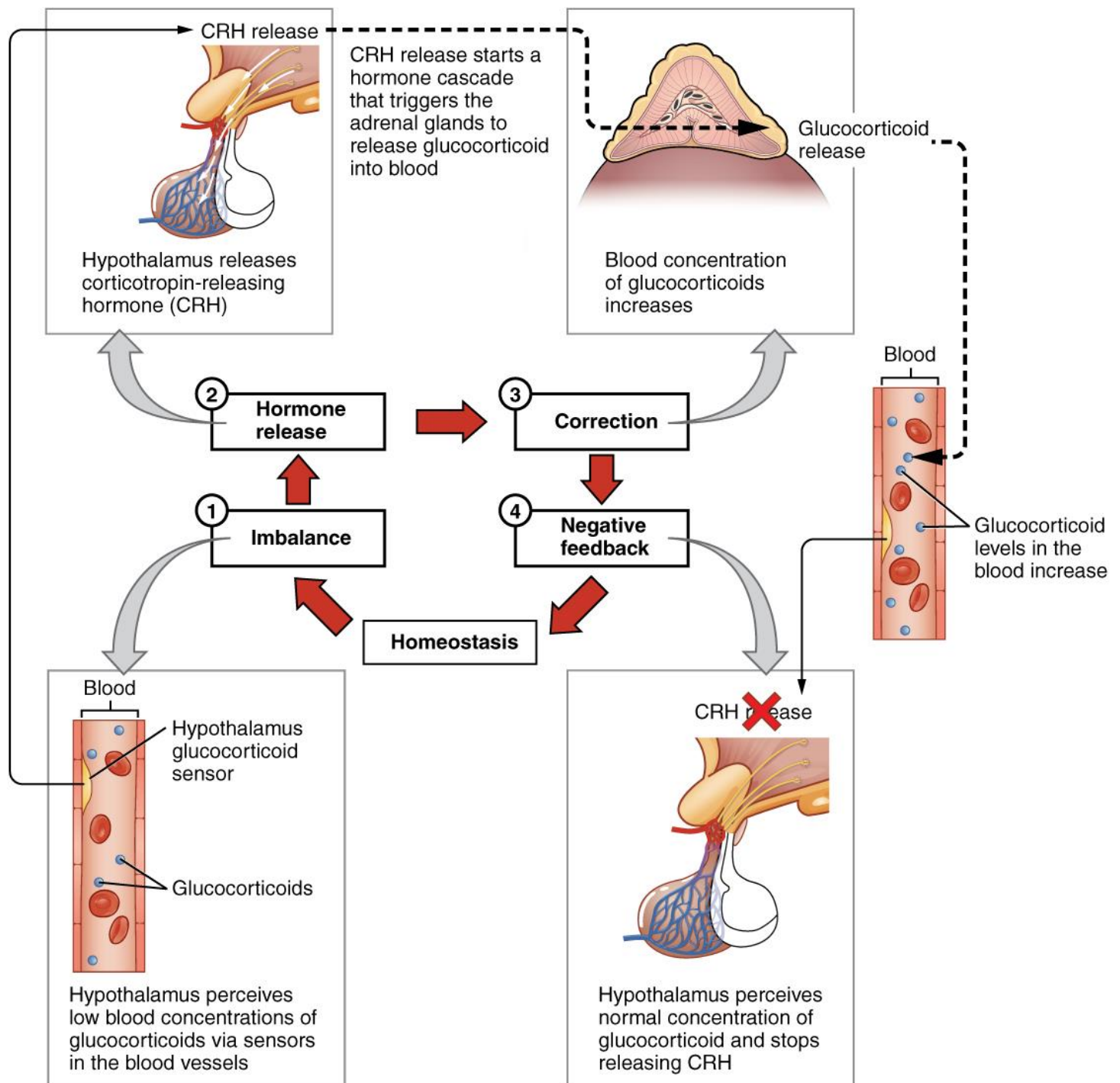


Figure 1.2 Example of a negative feedback loop in the secretion control of cortisol

(Credit: www.openstax.com)

## Structures to Identify:

- ☐ Hypothalamus
- ☐ Pituitary gland
  - Anterior portion
  - Posterior portion
- ☐ Pineal gland
- ☐ Thyroid gland
- ☐ Parathyroid glands
- ☐ Thymus
- ☐ Heart
- ☐ Pancreatic islets (Pancreas)
- ☐ Kidneys
- ☐ Adrenal glands
  - Adrenal cortex
  - Adrenal medulla
- ☐ Ovaries (Female)
- ☐ Testes (Male)

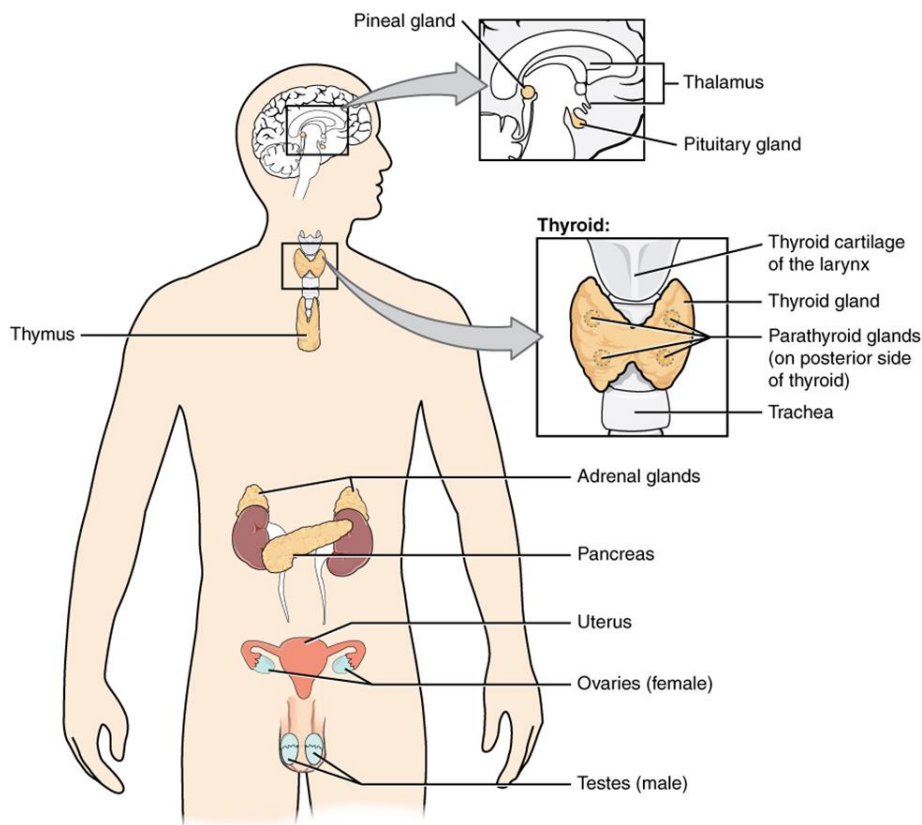


Figure 1.3 Location and names of several major endocrine organs (Credit: [www.openstax.com](http://www.openstax.com))

## Exercise 1 Activities

### Activity 1.1 Identifying Endocrine Organs and Tissues

Locate all of the **Structures to Identify** on the various human and organ models in the lab. Label each structure from the list above using sticky-note tabs and placing them on the structures. If time permits, label the structures with the hormones they produce. A complete list of hormones to identify can be found in the table under Activity 1.3.

## Activity 1.2: Matching Hormones to Site of Production

Complete the table of endocrine structures and their associated hormones. Indicate for each hormone whether the associated structure produces and/or stores it. Finally, notate the hormones solubility.

Endocrine Structure	Hormone	Produced, Stored or Both?	Water- or Lipid-Soluble?
Hypothalamus	1. Growth Hormone-Releasing Hormone	Both	Water
	2.		
	3.		
	4.		
	5.		
	6.		
Anterior Pituitary	1.		
	2.		
	3.		
	4.		
	5.		
	6.		

	7.		
Posterior Pituitary	1.		
	2.		
Pineal Gland			
Thyroid Gland	1.		
	2.		
	3.		
Parathyroid Glands			
Thymus			
Heart			
Pancreas	1.		
	2.		
Kidneys	1.		
	2.		
Adrenal Cortex	1.		

Adrenal Cortex	2.		
	3.		
Adrenal Medulla	1.		
	2.		
Ovaries	1.		
	2.		
	3.		
	4.		
Testes	1.		
	2.		



### Activity 1.3: Defining Hormone Functions and Target Tissues

Complete the missing information from the table below. You will want to refer back to this information throughout the semester as new organ systems and their major hormones are discussed.

<b>Hormone</b>	<b>Common name/ Abbreviation</b>	<b>Produced by: Stored in:</b>	<b>Physiological Action</b>
Growth Hormone Releasing Hormone	GHRH	Hypothalamus	Acts on somatotroph cells in the A.P.; stimulates release of Growth Hormone
Growth Hormone Inhibiting Hormone			
Thyrotropin Releasing Hormone			
Gonadotropin Releasing Hormone			
Prolactin Inhibitory Factor			
Corticotropin Releasing Hormone			
(Human) Growth Hormone			
Thyroid-Stimulating Hormone			
Follicle-Stimulating Hormone			
Luteinizing Hormone			
Prolactin			
Adrenocorticotrophic Hormone			
Melanocyte-Stimulating Hormone			

Anti-Diuretic Hormone			
Oxytocin			
Melatonin			
Triiodothyronine			
Thyroxine			
Calcitonin			
Parathyroid Hormone			
Thymopoietin			
Atrial natriuretic peptide			
Insulin			
Glucagon			
Erythropoietin			
Calcitriol			

Mineralocorticoids (Primary)			
Glucocorticoids (Primary)			
Gonadocorticoids (Primary)			
Epinephrine			
Norepinephrine			
Estrogens			
Progesterone			
Relaxin			
Inhibin			
Testosterone			
Inhibin			

## Post-Lab 1 Review Activities

Define in your own words and give an example of each:

- **Endocrine -**
- **Neuroendocrine –**
- **Hormone -**

- **Autocrine -**
- **Paracrine -**
- **Juxtacrine -**
- **Negative feedback loop -**
- **Positive feedback loop –**

Answer the following questions using your textbook or a reputable academic text.

**Water-Soluble Hormones:**

How do they travel through the body to their target tissue?

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How do they enter their target cell? Describe the process in general.

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Water-soluble hormones includes many different chemical classifications. Give several examples of each from the hormones in this lab exercise packet.

Amine Hormones -

Peptides & Protein Hormones –

Eicosanoid Hormones -

**Lipid-Soluble Hormones :**

How do they travel through the body to their target tissue?

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How do they enter their target cell? Describe the process in general.

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Lipid-soluble hormones includes many different chemical classifications. Give several examples of each from the hormones in this lab exercise packet.

Steroid Hormones –

Thyroid Hormones –

## Take Home Activity #1 (10 pts)

Must be completed in your own handwriting. No photocopies or typed answers accepted. You do not need to re-write the questions for each hormone- simply answer them in the order shown below.

### **Hormone Signaling Cascade**

1. List the name & abbreviation for each hormone.
    - a. Name the cell they are created within.
    - b. If its production/release is stimulated by a specific hormone, name that hormone.
    - c. If its production/release is not triggered by a hormone- what is the stimulus?
  2. Name a target cell for each hormone.
    - d. What physiological outcome results from each hormone's action on its target cell?
  3. Is the hormone water-soluble or lipid-soluble?
  4. What type of feedback loop occurs?
    - e. How is the hormone's specific feedback loop ended?
- Complete this exercise for:
    - Hypothalamic Hormones
    - Anterior Pituitary Hormones
    - Posterior Pituitary Hormones
    - Thyroid Hormone (T<sub>3</sub>/T<sub>4</sub> only)
    - Parathyroid Hormone
    - Adrenal Cortex Hormones
    - Adrenal Medulla Hormones
    - Renal Hormones
    - Pancreatic Hormones
    - Sex Hormones (male/female)