

# Chapter Twelve

## Endocrine System - Part I

So far, we have spent a great deal of time learning how the human body sends electrochemical signals through miles of fiber to respond to an infinite amount of stimuli. This week, we will look at another system that controls and coordinates the functions of all of the human body systems:

## The Endocrine System

You learned back in Chapter 2 that the epithelial tissue which covers the outside of the body contains areas known as *glands* which are responsible for creating and releasing specific chemicals throughout our body. These chemicals, known as **hormones**, are chemical messengers which travel throughout our body and help to maintain homeostasis much like the functions of our nervous system.

**Most functions performed by hormones are kept in balance through negative feedback mechanisms.**

In fact, both the nervous system and the endocrine system work together to control and regulate the actions of other cells, tissues, and systems within the body. They both are responsible for sending chemical signals in the body and they are known to control each other as well. At times, the nervous system controls the production of hormones; and, some hormones are capable of creating or halting the flow of nerve impulses as well. These are examples of how negative feedback works to maintain homeostasis within the body.

### **So how are these two systems different?**

The biggest difference between these two systems can be found in the response time for each system to respond to a stimulus. The nervous system utilizes a much faster mechanism of transporting a nerve impulse which can range from 1.7-269 mph (2.7-433 km/hr). By comparison, a response from the endocrine system may take several hours! This delay in response is caused by the slower path by which hormones travel - the blood.

Glands are not connected to other cells or tissues through networks of nerve cells. Once they secrete their hormones, it is the blood which transports these messengers throughout the body. Even though our blood is traveling at a pretty good rate (on average it takes under a minute for a blood cell to travel throughout the body), it still can take some time for these chemicals to reach their intended **target cells** which are in need of a hormonal response. And with the normal life expectancy of a hormone being less than one hour, a gland may be secreting lots of its chemical messengers over a long period of time before the target cells can be reached.

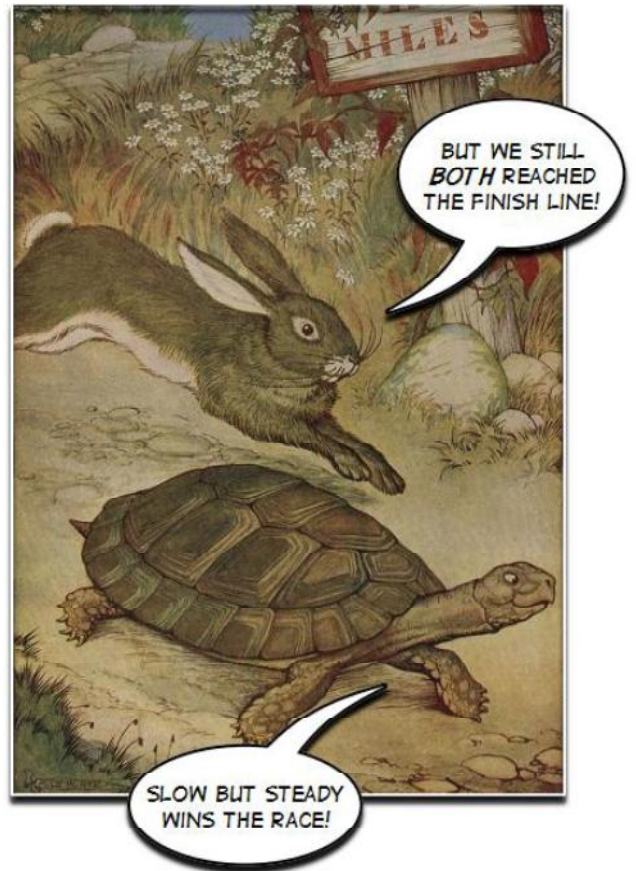
Target cells utilize a similar "lock and key" method of detecting specific hormones just as our chemoreceptors do for our sensations of smell and taste. Target cells have special receptors (locks) on their outer membranes that fit specific "keys" located on individual hormones. Once bound together, the chemical message can be read and interpreted by the cell.



## What other differences exist between these two systems?

Even though both systems release chemical signals within the body, it is a question of distance which causes these systems to be different. If you recall from Chapter 8, chemical signals are shared where two nerve cells meet through areas known as *synapses* within the nervous system. The distance between these two cells are amazingly small compared to the distance traveled by hormones throughout the massive network of blood vessels throughout the body.

In addition, the effects caused by hormones tend to last longer than those of nerve impulses...



If the speed of the nervous system can be imagined to be a race car, then the endocrine system could be compared to a semi-truck. Both get the job done, but they each require different amounts of time to start up and slow down!

It's time to start looking at the key organs which make up the endocrine system. Allow me to introduce you to the major endocrine glands:

**Pituitary, Thyroid, Parathyroid, Pineal,  
and Adrenal glands**

In addition to these glands, the human body has several organs which have the important role as producers of chemical messengers. The following chart will give you a brief list of these organs and the hormones they secrete:

Gland/Organ	Hormone(s) produced
Anterior lobe (pituitary)	Thyroid-stimulating hormone (TSH) Adrenocorticotrophic hormone (ACTH) Follicle-stimulating hormone (FSH) Lutenizing hormone (LH) Prolactin (PRL) Growth hormone (GH)
Posterior lobe (pituitary)	*Antidiuretic hormone (ADH) *Oxytocin
Thyroid	Thyroxine (T <sub>4</sub> ) Triiodothyronine (T <sub>3</sub> ) Calcitonin (CT)
Parathyroids (4)	Parathyroid hormone (PTH)
Adrenal (cortex)	Mineralocorticoids (Aldosterone) Glucocorticoids (Cortisol)
Adrenal (medulla)	Epinephrine (adrenaline) Norepinephrine (noradrenaline)
Pancreas	Insulin Glucagon
Thymus	Thymosins
Pineal	Melatonin
Ovaries	Estrogens Progesterone
Testes	Testosterone Inhibin

\* *These hormones are not produced by the pituitary's posterior lobe; rather, they are produced by the hypothalamus and secreted by the posterior lobe.*

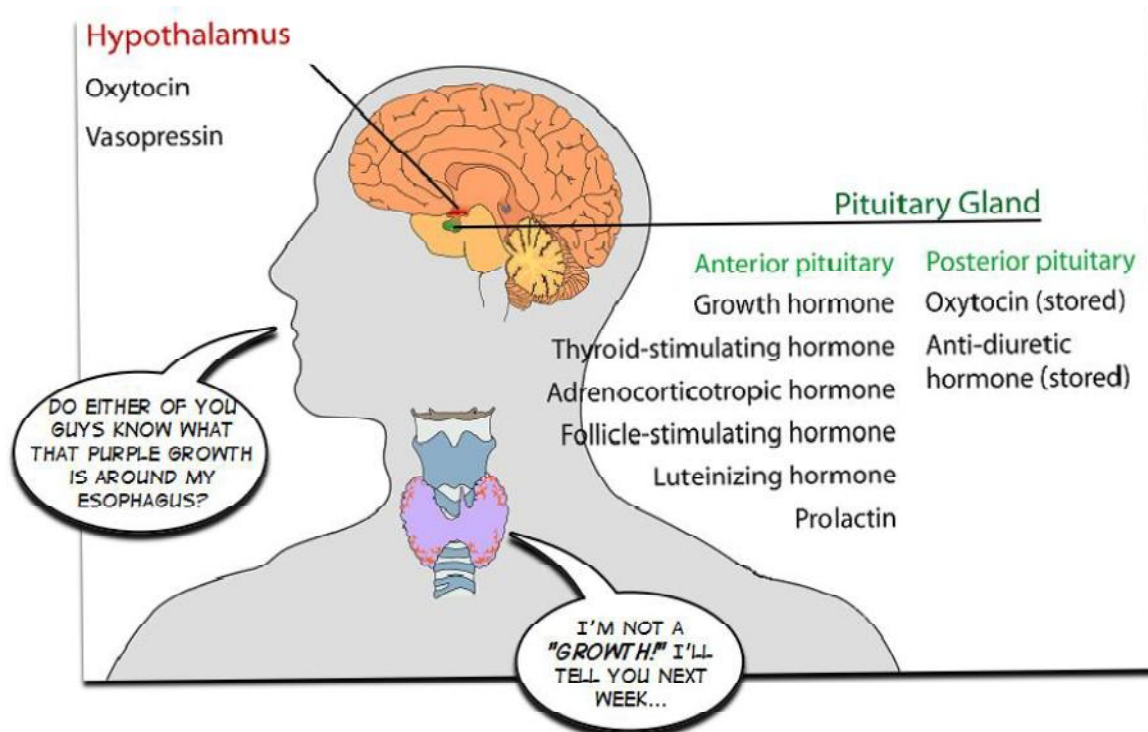
# Pituitary glands

It doesn't take a rocket scientist to see from this chart that the **pituitary glands** (yes... there are two of them!) produce the majority of the hormones in our body. In fact, your understanding of this gland is vital to bridging the gap between the nervous system and the endocrine system. Let me explain...

This "bridge" was first mentioned back in Chapter 9 when you learned of a structure known as the *hypothalamus* existing between the medulla oblongata and the cerebrum. This part of the brain is responsible for regulating a large amount of our vital functions including body temperature, water balance, sleep-wake cycles, appetite, emotions, and nearly all of the hormones within our body.

The hypothalamus acts like a supervisor to the pituitary gland by receiving stimuli from the brain and delegating orders into this vital structure of our endocrine system.

**All of these glands and organs are important; however, it is the pituitary gland working with the hypothalamus in the brain that really keeps this system working!**



The pituitary gland is protected quite well by the bones and tough membranes within the skull. It is about the size and shape of a large flattened pea. On average, it measures 0.4 inches (1 cm) long, 0.4 to 0.6 inches (1 to 1.5 cm) wide, and 0.1 inches (0.5 cm) thick. It contains two different sections known as the **anterior lobe** and the **posterior lobe**.

As you can see from the chart, the anterior lobe is responsible for the majority of hormones produced by the pituitary gland and takes up about 75% of its size. Only the anterior lobe is responsible for manufacturing hormones. It is the hypothalamus which is responsible for producing the hormones ADH and oxytocin and delivering them into the posterior lobe for transport throughout the body.

## The hormones produced in the anterior lobe of the pituitary gland include the following:

### Follicle-stimulating hormone (FSH):

Target cells for this hormone = Ovaries in females and testes in males

This hormone has different functions for the reproductive systems of men and women. In men, FSH stimulates the production of **sperm** (male reproductive cells) within the **testes** (male reproductive organs).

In women, FSH stimulates the production of **eggs** (female reproductive cells) within the **ovaries** (female reproductive organs).

### Luteinizing hormone (LH):

Target cells for this hormone = Ovaries in females and testes in males

LH stimulates the production of hormones utilized by the reproductive system. These hormones include *progesterone*, *estrogen*, and *testosterone*. Each of these hormones has specific actions which affect males and females in different ways.

**Prolactin (PRL):**

Target cells for this hormone = Mammary glands

PRL is a hormone which helps women to produce milk to feed young offspring from their **mammary glands** through a process called **lactation**.

**Thyroid-stimulating hormone (TSH):**

Target cells for this hormone = Thyroid gland

TSH controls the production of two hormones within the thyroid gland: *thyroxine* ( $T_4$ ) and *triiodothyronine* ( $T_3$ ). We will look at these two hormones in the next chapter when we explore the thyroid gland in detail.

**Adrenocorticotrophic hormone (ACTH):**

Target cells for this hormone = Adrenal cortex gland

ACTH acts on the adrenal cortex gland to produce the hormones *cortisol* and *aldosterone*. Both of these hormones play an important part in regulating the amount of sugar and minerals within our bodies.

**Growth hormone (GH):**

Target cells for this hormone = Muscle and bone tissue

**Growth hormone** acts on many different skeletal tissues within the body to stimulate their growth. This is the only hormone secreted by the anterior lobe of the pituitary gland that has a general effect on nearly every cell in the body.

**Only two hormones are associated with the posterior lobe of the pituitary gland:**

## **Oxytocin and Antidiuretic hormone (ADH)**

*Don't forget! The posterior lobe of the pituitary gland does not produce these two hormones. It is the hypothalamus which takes care of this job. The posterior lobe is responsible for transporting these two important hormones to the target cells of the body.*



**Oxytocin:**

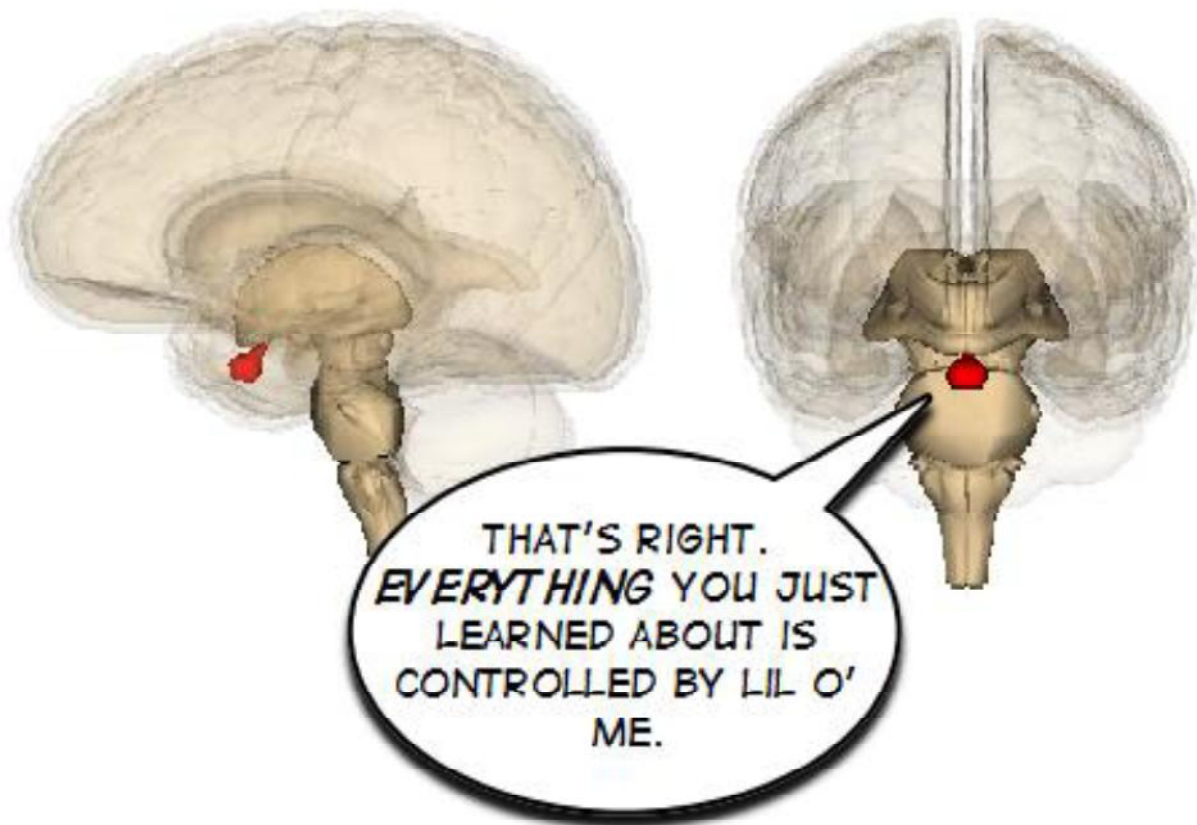
Target cells for this hormone = Uterus

The female **uterus** is an organ where offspring are grown during pregnancy. Oxytocin stimulates the smooth muscles of the uterus to contract which helps to push the child out during childbirth.

**Antidiurectic hormone (ADH):**

Target cells for this hormone = Kidney cells

The release of **ADH** into the bloodstream is used to balance the volume of fluids within the body. When your body is dehydrated, losing dangerous amounts of blood (known as a **hemorrhage**), or your blood contains a high concentration of ions, ADH acts on cells within the kidney to decrease the amount of urine that is to be excreted.



As you can see, the pituitary gland is rather busy throughout the day! We owe our lives to the functions of these organs. In the next chapter, we will be exploring the rest of organs and hormones of the endocrine system.

Match the following vocabulary terms with their correct definition:

adrenocorticotrophic hormone  
(ACTH)  
antidiurectic hormone (ADH)  
prolactin (PRL)  
luteinizing hormone (LH)  
growth hormone (GH)  
thyroid-stimulating hormone  
(TSH)  
anterior lobe  
eggs  
hemorrhage

hormones  
lactation  
mammary glands  
ovaries  
oxytocin  
pituitary glands  
posterior lobe  
sperm  
target cells  
testes  
uterus

- 1) \_\_\_\_\_ cells identified for specific chemical reactions by individual hormones
- 2) \_\_\_\_\_ chemical messengers which travel throughout the body and help to maintain homeostasis
- 3) \_\_\_\_\_ female reproductive cells
- 4) \_\_\_\_\_ female reproductive organs
- 5) \_\_\_\_\_ glands which produce and secrete milk in females
- 6) \_\_\_\_\_ hormone which acts on many different tissues within the body to stimulate their growth
- 7) \_\_\_\_\_ hormone which acts on the adrenal cortex gland to produce the hormones cortisol and aldosterone
- 8) \_\_\_\_\_ hormone which helps women to produce milk from their mammary glands

- 9) \_\_\_\_\_ hormone which stimulates the smooth muscles of the uterus to contract during childbirth
- 10) \_\_\_\_\_ hormone which targets ovaries and testes; stimulates the production of hormones utilized by the reproductive system
- 11) \_\_\_\_\_ hormone which targets the kidney cells to balance the volume of fluids within the body
- 12) \_\_\_\_\_ hormone which targets the thyroid gland to control the production of thyroxine (T4) and triiodothyronine (T3)
- 13) \_\_\_\_\_ male reproductive cells
- 14) \_\_\_\_\_ male reproductive organs
- 15) \_\_\_\_\_ one of two lobes within the pituitary gland; produces thyroid-stimulating hormone and adrenocorticotrophic hormone
- 16) \_\_\_\_\_ one of two lobes within the pituitary gland; receives and transports antidiuretic hormone and oxytocin which are produced by the hypothalamus
- 17) \_\_\_\_\_ organ where offspring are grown during pregnancy
- 18) \_\_\_\_\_ process by which women produce milk from their mammary glands
- 19) \_\_\_\_\_ the loss of a large amount of blood
- 20) \_\_\_\_\_ two glands located within the skull; responsible for the majority of hormone production

## Choose the correct answer from the following questions:

1) Which of these hormones does NOT play a role in reproduction:

- A) estrogen
- B) luteinizing hormone
- C) testosterone
- D) follicle-stimulating hormone
- E) antidiuretic hormone

2) Which one of the following hormones is NOT produced by the anterior lobe of the pituitary gland:

- A) thyroid-stimulating hormone
- B) oxytocin
- C) growth hormone
- D) prolactin
- E) luteinizing hormone

3) Negative feedback mechanisms regulate:

- A) hormones of the anterior lobe of the pituitary gland
- B) very few hormones
- C) most hormones
- D) hormones of the posterior lobe of the pituitary gland

4) The hypothalamus is most closely connected with the:

- A) thymus gland
- B) thyroid gland
- C) pituitary gland
- D) pineal gland
- E) pancreas

**5) Growth hormone:**

- A) acts on the adrenal cortex to produce cortisol and aldosterone
- B) is produced by the posterior lobe of the pituitary gland
- C) promotes growth in long bones and skeletal muscles
- D) is secreted by the thymus gland

**6) The chemical messengers of the endocrine system are known as:**

- A) stimuli
- B) neurons
- C) effectors
- D) hormones
- E) target cells

**Application Question:**

Predict the effect of a hot environment on ADH secretion and explain why this effect is advantageous to the human body.